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Assessing the status of the cod (*Gadus morhua*) stock in NAFO Subdivision 3Ps in 2010

Évaluation de l'état du stock de morue (*Gadus morhua*) dans la sous-division 3Ps de l'OPANO en 2010

B.P. Healey[1], E.F. Murphy[1], J. Brattey[1], N.G. Cadigan[1], M. J. Morgan[1], D. Maddock Parsons[1], D. Power[1], R. Rideout[1], E. Colbourne[1], and J.-C. Mahé[2]

[1]Science Branch
Department of Fisheries and Oceans
P.O. Box 5667
St. John's NL A1C 5X1

[2]IFREMER
Station de Lorient
8, rue François Toullec 56100
Lorient France

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TABLE OF CONTENTS / TABLE DES MATIÈRES

ABSTRACT

The status of the cod stock in Subdiv. 3Ps was assessed during a regional assessment process held during October of 2010. Stock status was updated based upon information collected up to spring 2010. Principal sources of information available for the assessments were: reported landings from commercial fisheries, oceanographic data, a time series of abundance and biomass indices from Canadian winter/spring research vessel bottom trawl surveys, inshore sentinel surveys, science logbooks from vessels <35 ft, and tagging studies. The total allowable catch (TAC) for the 2009-10 fishing season was set at 11,500 t. Total landings for the 2009-10 management year (April 1-March 31) were 8,892 t or just 77 % of the TAC. This is atypical, and industry participants indicated this discrepancy was primarily due to a large reduction in prices, additional market considerations and some reduction in fish availability offshore. The 2010-11 fishery was still in progress at the time of the RAP with provisional landings totaling of 5,600 t. The removals through recreational fishing are unknown since 2007, but based on previous estimates are thought to be a small fraction (~1 %) of the commercial landings.

A complex of stock components are exploited in Subdiv. 3Ps. Thus the impact of fishing at specific TAC levels on all components cannot be quantified. However, the DFO RV survey covers most of the stock, and it is thought that survey trends broadly reflect overall stock trends.

The abundance index from the 2010 DFO RV spring survey was 27 % higher than that of 2009, and is now above the time-series (1983-2010) average. This increase is largely due to the relatively abundant 2006 year-class. The biomass index for 2010, however, remains similar to the 2009 value, less than the time-series average. The 2006 year-class is estimated to be as strong as the 1997 and 1998 year-classes, which contributed to stock growth and supported commercial fisheries for several years. Catch rates from inshore sentinel surveys and logbooks for vessels <35 ft suggest stability.

Spawning stock biomass (SSB) estimated from a survey based cohort model decreased in recent years and in 2008 and 2009 there was a probability of 0.59 and 0.75, respectively, that SSB was below the limit reference point (LRP). The SSB in 2010 is estimated to be above the LRP, although the probability of being below the LRP is 0.37. A one year projection to 2011 indicated that survey SSB will increase if total mortality rates are similar to current values (i.e., within ±20 %), and that the probability of being below the LRP in 2011 is low (0.04 to 0.17).

RÉSUMÉ

L'état du stock de morue dans la sous-division 3Ps a été évalué lors d'un processus d'évaluation régionale qui s'est déroulé en octobre 2010. L'état du stock a été mis à jour selon les renseignements recueillis jusqu'au printemps 2010. Voici les principales sources de données utilisées dans les évaluations : les débarquements signalés des pêches commerciales, les données océanographiques, une série chronologique d'indices d'abondance et de biomasse obtenus par des relevés au chalut de fond effectués à l'hiver et au printemps au moyen d'un navire de recherche canadien, relevés côtiers de pêches sentinelles, des journaux de bord de navires de recherche scientifique de <35 pi ainsi que des expériences de marquage. Le total autorisé des captures (TAC) pour la saison de pêche 2009-2010 était fixé à 11 500 t. Les débarquements totaux pour l'année de gestion 2009-2010 (1er avril au 31 mars) étaient de 8 892 t ou 77 % du TAC. Ces résultats sont exceptionnels et les participants de l'industrie ont indiqué que cet écart était principalement attribuable à une grande réduction des prix, à d'autres facteurs liés au marché et à une certaine réduction de la disponibilité des poissons dans les zones extracôtières. Au moment du processus d'évaluation régionale, la saison de pêche 2010-2011était toujours en cours, et les données provisoires sur les débarquements totaux s'établissaient à 5 600 t. On ignore le nombre de prises dans le cadre de la pêche récréative depuis 2007, mais en fonction des estimations précédentes, on croit qu'il représente une faible fraction (~1 %) des débarquements commerciaux.

Un ensemble de composantes de stock de morue est exploité dans la sous-division 3Ps. En conséquence, l'impact de la pêche à des niveaux de TAC particuliers sur toutes les composantes ne peut pas être quantifié. Cependant, le relevé effectué par le navire de recherche du MPO couvre presque tout le stock, et l'on croit que les tendances observées reflètent généralement les tendances globales du stock.

L'indice d'abondance du relevé effectué par le navire de recherche du MPO au printemps 2010 était 27 % supérieur à celui de 2009, et est maintenant supérieur à la moyenne de la série chronologique (1983-2010). Cette augmentation est en grande partie attribuable à la classe d'âge de l'année 2006 relativement abondante. L'indice de biomasse en 2010 demeure toutefois semblable à la valeur de 2009, inférieur à la rnoyenne de la série chronologique. La classe d'âge pour l'année 2006 est considérée être aussi forte que les classes d'âge des années 1997 et 1998, qui ont contribué à la croissance du stock et ont alimenté les pêches commerciales pendant plusieurs années. Les taux de prises enregistrés dans les relevés côtiers de pêches sentinelles et indiqués dans les journaux de bord de navires de <35 pi laissent sous-entendre la stabilité.

La biomasse du stock reproducteur (BSR) estimée à partir d'un modèle de cohortes fondé sur des relevés a diminué au cours des dernières années et en 2008 et en 2009, on observait une probabilité de 0,59 et de 0,75 respectivement que la BSR soit inférieure au point de référence limite. Selon les estimations, la BSR sera supérieure au point de référence limite en 2010, bien que la probabilité qu'elle soit inférieure au point de référence limite soit de 0,37. Une projection d'un an jusqu'en 2011 a révélé que la BSR dérivée des relevés s'accroîtrait si les taux de mortalité totale étaient similaires aux valeurs actuelles (c.-à-d. à l'intérieur de ±20 %) et que la probabilité qu'elle soit inférieure au point de référence limite en 2011 était faible (0,04 à 0,17).

INTRODUCTION

This document gives an account of the 2010 assessment of the Atlantic cod (*Gadus morhua*) stock in NAFO Subdiv. 3Ps located off the south coast of Newfoundland (Figs. 1 and 2). The history of the cod fishery in NAFO Subdiv. 3Ps and results from other recent assessments of this stock are described in previous documents (see Brattey et al. 2007, 2008; Healey et al. 2011a and references therein). A regional assessment meeting was conducted during October 2010. Participants included DFO scientists, a scientist from IFREMER (France), DFO fisheries managers, government officials from the province of Newfoundland and Labrador, fishing industry representatives, and a representative of World Wildlife Fund (Canada).

Various sources of information on 3Ps cod were available to update the status of this stock. Commercial landings through mid-October 2010 were available, though catch at age was only updated to 2009 as the 2010 fishery and sampling thereof were ongoing. The results of the DFO research vessel survey during April 2010 was reviewed in detail and compared to previous survey results. Additional sources of information included science logbooks for vessels <35 ft (1997-2009), inshore sentinel surveys from 1995 to 2009 (Maddock Parsons and Stead 2011) and recaptures of tagged cod (received as of October 2010) from tagging conducted in 3Ps during 1997-2010 (Brattey and Healey 2006). A survey-based assessment model (Cadigan 2010) was used to smooth signals in the research-vessel (RV) survey, and provided estimates of biomass, total mortality and recruitment for that portion of the stock covered by the DFO RV survey. Short-term projections of these estimates under mortality similar to recent levels were also evaluated to advise on the management of this stock.

ENVIRONMENTAL OVERVIEW

Oceanographic information collected during the spring DFO RV surveys indicated that near-bottom temperatures throughout NAFO subdivision 3Ps have warmed in both 2009 and 2010, increasing to above normal values. For example, the area of <0 °C water on the ocean floor has decreased to about 10 %, compared to almost 30 % in 2007 and 2008 (Colbourne et al. 2011). Survey catches of cod are generally lower in years when there are relatively large incursions of cold/fresh water from the eastern NL shelf. The areal extent of bottom water with temperatures >3 °C has remained relatively constant at about 50 % of the total 3P area, although actual temperature measurements show considerable inter-annual variability. The current conditions are comparable to those of the late 1970's and early 1980's when the stock was more productive.

A comparison of the cumulative distribution of bottom temperatures at survey locations and temperature weighted by survey catches of cod indicated that cod generally avoid colder (<-1 °C) water. In years when increased volumes of cold water are present on the banks, the distribution of cod is more compact, and found mainly in the warmer waters along the slopes and deeper channels. Conversely, in years where temperatures are warmer, with cod catches across much of the surveyed area.

TOTAL ALLOWABLE CATCHES and COMMERCIAL CATCH

TOTAL ALLOWABLE CATCH (TAC)

A history of the TAC for this stock over 1959-2009 is presented in Table 1 (see also Fig. 3).This stock was subject to a moratorium on all fishing from August 1993 to the end of 1996. More recently, the TAC was set at 13,000 t for management years April 1, 2006-March 31, 2007 through April 1, 2008-March 31, 2009. The TAC for both the 2009-10 and 2010-11 seasons has been set at 11,500 t.

COMMERCIAL CATCH

Catches (reported landings) from 3Ps for the period 1959 to 15 October 2010 are summarized by country and separately for fixed and mobile gear in Table 1 and Figs. 3a and 3b. Prior to the moratorium, Canadian landings for vessels <35 ft were estimated mainly from purchase slip records collected and interpreted by Statistics Division, Department of Fisheries and Oceans. Shelton et al. (1996) emphasized that these data may be unreliable. Post-moratorium landings for Canadian vessels <35 ft have come mainly from a dock-side monitoring program initiated in 1997. Landings for Canadian vessels >35 ft come from logbooks. Non-Canadian landings (only France since 1977) are compiled from national catch statistics reported by individual countries to NAFO and there is generally a lag in the submission of final statistics; consequently, the most recent entries in Table 1 are designated as provisional. In recent years, the provisional information for landings by France are provided directly by French government officials.

The stock in the 3Ps management unit was heavily exploited in the 1960's and early 1970's by non-Canadian fleets, mainly from Spain and Portugal, with reported landings peaking at about 87,000 t in 1961 (Table 1, Fig. 3a). After extension of jurisdiction (1977), cod catches averaged between 30,000 t and 40,000 t until the mid-1980s when increased fishing effort by France led to increased total reported landings, with catches increasing to about 59,000 t in 1987. Subsequently, reported catches declined gradually to 36,000 t in 1992. Catches exceeded the TAC throughout the 1980's and into the 1990's. The Canada-France boundary dispute led to fluctuations in the French catch during the late 1980's. Under advice from the Fisheries Resource Conservation Council, a moratorium was imposed on all directed cod fishing in August 1993 after only 15,216 t had been landed, the majority being taken by the Canadian inshore fixed gear fishery (where inshore is typically defined as unit areas 3Psa, b, and c; refer to Fig. 1). Access by French vessels to Canadian waters was restricted in 1993. Under the terms of the 1994 Canada-France agreement, the Canadian and French shares of the TAC are 84.4 % and 15.6 %, respectively.

Since 1997, most of the TAC has been landed by Canadian inshore fixed gear fishermen, with remaining catch taken mainly by the mobile gear sector fishing the offshore, i.e., unit areas 3Psd, e, f, g, and h (Table 1, Fig. 3a, and 3b). This general pattern has continued since the fishery reopened in 1997, but there has been a slight increase in landings from offshore unit areas due to some smaller fixed gear vessels redirecting their effort to offshore fishing areas. However, in 2009, some of these patterns differed as effort and landings were reduced. During the 2009 calendar year, total reported landings were 9,762 t with the Canadian inshore fixed gear sector accounting for 5,870 t (60 %) of the total (Table 1). Total landings for the 2009-10 management year (April 1–March 31) were 8,892 t or just 77 % of the TAC. This is atypical as the TAC has been fully utilized if not exceeded in each year since Canadian jurisdiction was extended in 1977 (excluding moratorium). Industry participants at the October 2010 assessment indicated several reasons contributing to this shortfall, but primarily it was thought to be due to a large reduction in prices (approximately 50 % in one year), additional market considerations and a reduction in the availability of large fish offshore during winter 2010.

Preliminary landings data for 2010 to October 15th totaled 5,560 t. Although the 2010-11 fishing season is incomplete, these totals to date are again relatively low due to reductions in fishing effort (DFO 2010) and it is unlikely that the full TAC will be landed.

Line-trawl (=longline) catches dominated the fixed gear landings over the period 1977-93, reaching a peak of over 20,000 t in 1981 and typically accounting for 40-50 % of the annual total for fixed gear (Table 2, Fig. 4). In the post-moratorium period, line-trawls have accounted for 16-23 % of the fixed gear landings. Gillnet landings increased steadily from about 2,300 t in 1978 to a peak of over 9,000 t in 1987, but declined thereafter until the moratorium. Gillnets have been responsible for the dominant portion of the inshore catch since the fishery reopened in 1997, with gillnet landings exceeding 50 % of the TAC for the first time in 1998. Gillnets have typically accounted for 70-80 % of the fixed gear

landings since 1998. Gillnets accounted for a lower percentage of the fixed gear landings in 2001 (60 %), partly due to a temporary management restriction in their use that was removed part way through the fishery following extensive complaints from industry. Gillnets are also being used extensively in the offshore areas in the post-moratorium period (see below). Cod trap landings from 1975 up until the moratorium varied considerably. Since 1998, trap landings have been reduced to negligible amounts (<120 t). Hand-line catches were a small component of the inshore fixed gear fishery prior to the moratorium (about 10-20 %) and accounted for about 5 % of landings on average for the post-moratorium period. However, hand-line catch for 2001 shows a substantial increase (to 17 % of total fixed gear) and this may reflect the temporary restriction in use of gillnets described above. In 2009, the proportion of hand-line catch doubled and increased to almost 10 % of the fixed gear catch as buyers paid a higher price for hook-caught fish than for gillnet landings.

A summary of reported landings for 2009 and for 2010 (to date) by month and unit area is provided in Table 3. In general, the spatial-temporal pattern is similar in to those of recent years. Inshore landings are low in March and April, mostly arising from by-catch of cod in other offshore fisheries. The vast majority of landings from the inshore areas (3Psa, b, c) are taken in June-November, with highest landings in July, particularly in 3Psc.

In the offshore, monthly landings tended to be more variable among unit areas. Almost 50 % of the 2009 offshore landings were taken from 3Psh during January and February combined with catches from 3Psf in November. Only 13 % of offshore landings occurred within April-August 2009 (22 % in 2008) relatively low effort through the spring and summer, but with considerable landings in the late fall/early winter otter trawl fisheries. Landings from 3Pse and 3Psf were also higher in fall from vessels fishing gillnets.

An examination of recent temporal patterns by management year (Fig. 5) indicates an increasing fraction of landings taken later in the year. This is likely influenced by buying practices which have paid a premium for higher-yield fish taken later in the year. Given that the TAC was not fully utilized in the previous season (2009-10) and is unlikely to be utilized during ongoing season, it is possible that this trend may not persist.

The distribution of post-moratorium catches among unit areas is illustrated in Fig. 6. The inshore (3Psa, 3Psb, and 3Psc) has consistently accounted for most of the reported landings. These have typically been highest in Placentia Bay (3Psc), ranging from 2,800 t to almost 11,650 t with 28-51 % of the annual 3Ps catch coming from this unit area alone. This percentage had declined steadily over 1999-2005, but has increased in the most recent three years and is now presently 35 % of the 3Ps total landings. Landings from 3Psa and 3Psb have been fairly consistent at about 1,100-3,200 t and generally between 7-12 % and 9-18 %, respectively, of the annual total. Most of the offshore landings have come from 3Psh and 3Pse/f (Halibut Channel and the southeastern portion of St. Pierre Bank). The percentage of total landings from 3Psf declined considerably in 2008. Unit area 3Psg continues to have the lowest landings (<4 % of the annual total each year since 1997). During the first quarter of 2009, no month or unit-area breakdown of French catch is available though these landings were known to be taken from either unit area 3Psf or 3Psh (L. Yetman, Fisheries and Aquaculture Management Branch, DFO, St.John's; pers. comm.). The 2009 values illustrated in Fig. 6 do not include these catches and hence are not representative of all landings.

The 2009-10 and 2010-11 (1st of April to 31st of March) conservation harvesting plans placed various seasonal and gear restrictions on how the 3Ps cod fishery in Canadian waters could be pursued. Full details of these measures, which differ among fleet sectors, are available from the DFO Fisheries and Aquaculture Management (FAM) branch in St. John's.

CATCH-AT-AGE

Samples of length and age composition of catches were obtained from the inshore gillnet, line-trawl and hand-line fisheries and the offshore otter trawl, gillnet, and line-trawl fisheries by port samplers and fishery observers. Additional sampling was obtained from the sentinel fishery. Sampling of French (St. Pierre and Miquelon, SPM) catches is conducted by IFREMER. During 2009, 51,652 and 730 fish length measurements of Canadian and French catches were taken. In addition, 5,351 and 32 otoliths from catches of each country to determination age composition of the catches (Table 4). The totals for French sampling in 2009 are anomalously low resulting from a transition between scientific personnel stationed in St. Pierre. Canadian sampling totals are lower than in previous years and resulted from both reduced landings and reduced sampling efforts. Despite these reductions, sampling was reasonably well distributed spatially and temporally across the gear sectors. Sampling of lengths and ages of the Canadian and French catches during January-March 2010 was also undertaken, but data were not available at the time of the assessment and will be considered in future years.

The age composition and mean length-at-age of commercial catches were calculated as described in Gavaris and Gavaris (1983). The average weights were derived from a standard length-weight (wt) relationship where:

$$\log(wt)=3.0879*\log(length)-5.2106.$$

Catch-at-age for all gears combined based on sampling of Canadian and French vessels in 2009 is summarized in Table 5 and also Fig. 7. All age determinations were made by Canadian technical staff. During the February/March 2009 Zonal Cod assessment, a research recommendation highlighted a need to further examine discrepancies in age determinations from French and Canadian technical staff. This exchange occurred during late 2009 with results reported by Healey et al. (2011b). A workshop to improve consistency between the interpretations by staff in each country is scheduled for 2012.

In the 2009 landings from all gears combined, a wide range of ages (ages 4-20) are represented. The distribution of catches in 2009 was more compact than in other recent years, as most of the catch (80 % of catch numbers) is comprised of ages 5-8 (Table 5, Fig. 7a). The modal age in the 2009 catch was age 6, with approximately 1.0 million individuals taken (26 % of total by numbers; Fig. 7b). The 1997 and 1998 year classes were the focus of the fishery for many years, and although they are outside of the range of gillnet selectivity, they comprised 13 % of the landed weight. Annual contributions to the catch-at-age are illustrated using a standardized proportion at age figure (Fig. 7c). Over the longer time series of catch (1977-2010), changes in the age distribution of annual catches (reflecting differences in gear composition of the catch pre and post-moratorium described previously) are evident. In this figure, cohorts which are strongly indicated in the commercial catch are large grey circles, while those which are now well represented in the catches are large black circles. Over the past decade, this clearly illustrates the significance of the 1997 and 1998 year-classes to the total catch along with the below average to average contribution from several successive year-classes. Commercial catches of the 2004 cohort thus far indicate contributions of larger than average proportions of the annual catches though this cohort is only beginning to recruit to the fishery.

Detailed information on the catch from the first three months of 2010 was not available at the time of the assessment; most catches over January-March are typically taken by mobile gear in the offshore.

Catch at age for the three main gear types in 2009 show (Fig. 8) that all gears catch a range of ages, but the dominance of gillnet selectivity on ages 5-8 is evident, whereas line-trawls caught a larger fraction of younger fish (mainly ages 4-7). Otter trawls indicate a relatively wide range of ages captured, though the modal age was age 6, and 66 % of the catch numbers were from age groups 5-7. In addition, 14 % of the otter trawl catch numbers were from ages 11 to 13 and numbers landed over these ages exceeded those from all other gears.

A time series of catch numbers-at-age (ages 3-14 shown) for the 3Ps cod fishery from 1959 to 2009 is given in Table 6. As noted in recent assessments (e.g. Brattey et al. 2008), there are discrepancies in the sum of the product check for the 1959-76 catch-at-age and attempts have been made to clarify these discrepancies by checking for missing catch and by adding plus group catch, but neither of these adequately explained the discrepancies. Until these discrepancies are resolved, it is recommended that catch at age prior to 1977 not be used in population analyses.

The catch-at-age data indicate that in the pre-moratorium period the landings were dominated by young fish, typically aged 4-6, whereas in the post moratorium period slightly older ages (i.e., ages 5-8) have been more common which likely reflects the switch in dominant gears from line-trawl and traps to gillnet.

WEIGHT-AT-AGE

Mean weights-at-age in the 3Ps fishery (including landings from the commercial and food fisheries and the sentinel surveys) are given in Table 7a and Fig. 9. Beginning of the year weights-at-age are given in Table 7b and Fig. 9. The mean weights-at-age are derived from the sampling of catches taken by several gears in various locations at various times of the year; the weights at age may therefore vary with season and gear, and possibly by geographic area. The annual means by gear vary considerably; for example, mean weights-at-age in the 2002 3Ps fishery tended to be least in hand-line and greatest in offshore mobile gear (predominantly otter trawl) (Brattey et al. 2003), with the weight of the 1994 year-class at age 8 in the former being less than half the weight in the latter.

For young cod (ages 3-6), weights-at-age computed in recent years tend to be higher than those in the 1970s and early 1980s (Table 7a; Fig. 10). The converse is true for older fish. Sample sizes for the oldest age groups (>10) have been low in recent years due to the relative scarcity of old fish in the catch. Interpretation of trends in weights-at-age computed from fishery data is difficult because of among-year variability in the proportion at age caught by gear, time of year and location.

SENTINEL SURVEY

The sentinel survey has been conducted in 3Ps since 1995 and there are now fifteen complete years of catch and effort data (see Maddock Parsons and Stead 2011). Sentinel activity for 2010 was ongoing at the time of the assessment; this data will be reviewed in subsequent years.The sentinel survey continues to produce a time series of catch/effort data and biological information collected by trained fish harvesters at various inshore sites along the south coast of Newfoundland. Sentinel fishers typically fish a control and an experimental site; the location of the control site is fixed, whereas the location of the experimental site can change only within the local area. In 2009, there were 13 active sites in 3Ps, using predominantly gillnets (5½" mesh) in unit area 3Psc (Placentia Bay) and line-trawls in 3Psb and 3Psa (Fortune Bay and west). One 3¼" gillnet was also fished at each of 5 sites in Placentia Bay one day per week. Fishing effort was less in 1999 (6 weeks), 2003 and 2004 (8 weeks each), than most other years (9-12 weeks), but since 2005 an average of 10 weeks has been maintained. Most fishing takes place in fall/early winter. Maddock Parsons and Stead (2001, 2003a, 2003b, 2004, 2005, 2006, 2007, 2009, 2011.) have produced a time series of weekly average catch rates and annual relative length frequencies (number of fish at length divided by amount of gear). Catch rates for 5½" gillnets in 2009 remain low and are similar to those recorded for 1999-2008. Line-trawl catch rates in 2009 are slightly below the 2008 level, and remain comparable to 1999-2008 levels.

As in previous assessments, an age dis-aggregated index of abundance was produced for gillnet (5½" mesh) and line-trawl sampling. There is insufficient data from the 3¼" gillnets to develop a standardized index for this gear.

STANDARDIZED SENTINEL CATCH RATES

The catch from 3Ps was divided into cells defined by gear type (5½" mesh gillnet and line-trawl), area (unit areas 3Psa, 3Psb, and 3Psc), year (1995-2009) and quarter. Age-length keys (ALKs) were generated for each cell using fish sampled from both the fixed and experimental sites; however, only fish caught at the fixed sites were used to derive the catch rate indices. Length frequencies and ALKs were combined within cells. The numbers of fish at length are assigned an age proportional to the number at age for that particular cell length combination. Fish that were not assigned an age because of lack of information within the initial cell were assigned an age by aggregating cells until the data allowed an age to be assigned. For example, if there are no sample data in a quarter then quarters are combined to half-year, half-years are combined to year; if an age still cannot be assigned then areas are combined for the year. Since 2002, there are considerably fewer otoliths available for aging; annual sample sizes range between 248 and 454 otoliths per year from gillnet catches (compared to an average of 1050 otoliths during 1995-2002). For line-trawl there were <700 otoliths per year during 2003 and 2004, but the numbers increased to 1,132 otoliths during 2005 and to 1,160 during 2006. However, less than 1000 cod have been sampled from line-trawl effort in both 2007 and 2008. These variations are generally reflective of annual differences in the numbers of fish caught and decreased sentinel effort over time. However, there have been some changes in the proportion of sampled fished aged over the duration of the Sentinel program. Despite these decreases, there have been no major difficulties in aging the sampled catch. Further, the fraction of the catch sampled for age in recent years is comparable to earlier years.

Catch-at-age and catch per unit effort (CPUE) data were standardized using a generalized linear model to remove site and seasonal effects. For gillnets, only sets at fixed sites during June to November with a soak time between 12 and 32 hours were used in the analysis. For line-trawl, sets at fixed sites during June to November with a soak time less than or equal to 24 hours were used in the analysis. Prior to modeling, data are aggregated within a gear-division-site-month-year-age cell. Zero catches were generated for ages not observed in a set as sets with effort and no catch are valid entries in the model. Note that catch rates from the sentinel fishery are expressed in terms of numbers of fish, rather than catch weight as was used in the analyses of logbook data. This has important implications when comparing trends in these indices.

A generalized linear model (McCullagh and Nelder 1989) was applied to the sentinel catch and effort data for each gear type. The number of fish caught in each set is assumed to have a Poisson distribution. A log link function was chosen, and the factors included in the model were both "nested effects": month is nested within site and age is nested within year. Fishing effort is included as an offset term in the model. In the present assessment, the model adequately fitted data from gillnets and line-trawls, and all effects included in the model were significant.

Trends in standardized total (ages 3-10 combined) annual catch rates, expressed in terms of numbers of fish, are shown in Fig. 11a. Gillnet catch rates declined rapidly from 1997 to 1999 then remained stable but low from 1999 through to 2009. For line-trawls, catch rates show a decline from 1995, but have been relatively stable with no clear trend from 1997 to 2009.

Two standardized annual catch rate-at-age indices were also produced in the present assessment, one for each gear type. The standardized gillnet and line-trawl catch rate-at-age indices for 1995-2009 are given in Table 8 and Fig. 11b. For gillnets, several year classes were well-represented in catches during 1995-97 but these are replaced by weaker year classes in all subsequent years. It is

noteworthy that the 1997 and 1998 year classes did not yield improvements in the sentinel gillnet catch rates over 2002-06, when these year-classes would have been within the peak selection range of 5½" gillnets.

For line-trawls, catch rates-at-age in the beginning of the time-series were higher due to the 1989 and 1990 year-classes. In 2000-02, sentinel line-trawl catch rates improved for younger fish (3 and 4 year olds) as the 1997 and 1998 recruited to this index. Catch rates for older fish continued to decline. Both the 1997, and in particular, the 1998 year class were consistently measured by sentinel linetrawl. As noted previously, these year-classes contributed strongly to commercial catches for several years. In addition, the 1999 year class also appears reasonably strong at ages 4-5 then is generally below average for older ages. This year class is weak in sentinel gillnet and in other (mobile gear) indices. These year-classes were followed by several successive year-classes which were weaker; but catch rates of the 2004 year-class at ages 3-5 (in 2007-09) are higher (Table 8). In 2006, linetrawl catch rates for all ages (3-10) increased, suggesting a year effect in the data rather than a change in stock size (Fig. 11).

Although the sentinel indices did not increase in magnitude as the 1997 and 1998 year-classes were available to these gears, the age composition of the standardized estimates indicates that the 1997 year-class was consistently detected in the sentinel gillnets (Fig. 11b). Conversely, the 1998 year-class was consistently tracked by linetrawl sampling.

As described in recent 3Ps cod assessments, interpretation of the sentinel catch rate indices is difficult. Sentinel fisheries were free from competitive influences during 1995-96 as the commercial fishery was closed. However, commercial fisheries may have had some disruptive influence on the execution of the sentinel fishery during since 1997, particularly in Placentia Bay. The concentration of fishing effort in Placentia Bay, primarily with gillnets, may have had a negative influence on the sentinel gillnet catch rates. Competition with commercial fishers for fishing sites, local depletion, inter-annual changes in the availability of fish to inshore, and shifts in the timing of sentinel fishing to accommodate periods of commercial fishing could all influence mean catch rates between years. The extents to which such effects influence catch rates are not fully understood. These issues also complicate the interpretations of relative year-class strength over the time-series. The decline in sentinel gill net catch rates after the fishery reopened in 1997 are consistent with the inshore catch rate data from science log-books and the high estimates of exploitation from tagging in Placentia Bay. In contrast, the line-trawl catch rates, which mainly incorporate data from areas west of the Burin Peninsula, show less of a decline and rates show some indication of the appearance of the stronger 1997 and 1998 year classes. The cohort signals in the sentinel line-trawl are also reasonably consistent with the DFO RV survey index, the GEAC survey index (see below), and the commercial catch-at-age, all of which show that the 1997 and 1998 year classes were relatively strong.

SCIENCE LOGBOOKS (<35 ft sector)

A new science logbook was introduced to record catch and effort data for vessels <35 ft in the re-opened fishery in 1997. Prior to the moratorium, the only data for vessels <35 ft came from purchase slips, which provided limited information on catch and no information on effort. Since the moratorium, catch information comes from estimated weights and/or measured weights from the dockside monitoring program. Catch rates have the potential to provide a relative index of temporal and spatial patterns of fish density, which may relate to the overall biomass of the stock. Prior to the fall assessment meeting, there were about 138,000 records in the database. The total number of records has declined over time even over multi-year periods having common TAC. In addition, the percentage of the total cod catch for the <35 ft sector represented in the logbooks has decreased over time, from about 70 % in 1997 to about 50 % in recent years.

We present a catch rate index for data pertaining to the inshore fishery, i.e., unit areas 3Psa, 3Psb, and 3Psc. An initial screening of the data was conducted and observations were not used in the analysis if the amount of gear or location was not reported (or reported as offshore / outside of 3Psa, 3Psb or 3Psb), more than 30 gillnets were used, or <100 or >4,000 hooks were used on a line-trawl. As observed in previous assessments, preliminary examination of the logbook data indicated that soak time for gillnets is most commonly 24 hours with 48 hours the next most common time period. In comparison, line-trawls are typically in the water for a much shorter period of time – typically 2 hours with very few sets more than 12 hours.

The screening criteria described above have resulted in a substantial fraction of <35 ft catch not being available for analysis. For example, in 2009 only 24 % of the <35 ft gillnet catch and 35 % of the <35 ft linetrawl catch is included in the CPUE standardization. A major contributor to this loss of information is an increasing portion of logbooks records with invalid entries for the location fished. This occurs when logbook entries do not record a fishing location as shown on the map included in this logbook. (These are denoted as fishing areas 29-37 and illustrated in Fig. 12a). Most of these instances are generated from logbooks which report the location fished as either "10" or "11" – these references correspond to "species fishing areas" (e.g., Lobster Area 10) which are relatively large and include more than one of the fishing locations illustrated in Figure. 10a. Therefore it is not possible to resolve these entries to the finer-scale areas indicated in the logbook, and, consequently, a substantial fraction of the catch and effort data from smaller vessels is excluded by our selection criteria.

As in previous assessments, effort was treated as simply the number of gillnets, or hooks for line-trawls (1000's), deployed in each set of the gear; soak times were not adjusted as the relationship between soak time, gear saturation and fish density is not known. Catch rates from science logbooks are expressed in terms of weight (whereas those from the sentinel fishery are expressed in terms of numbers); commercial catches are generally landed as head-on gutted and recorded in pounds; these were converted to whole weight (in kg) by multiplying by a gutted to whole weight conversion factor (1.2) and converting pounds to kilograms (2.203).

The frequency distribution of catches per set is skewed to the right for both gears (not shown). For gillnets, catches per set are typically 100-200 kg with a long tail on the distribution extending to about 2 t. The distribution of catches for line-trawls was similarly skewed.

The catch from 3Ps was divided into cells defined by gear type (gillnet and line-trawl), location (numbered 29-37, as described above) and year (1997-2009).

Initially, un-standardized CPUE results were computed and examined; in this preliminary analysis plots of median annual catch rate for gillnets and line-trawl were examined for each year-location. Catch rates for gillnets tend to be higher in areas 29-32 (Placentia Bay and south of Burin Peninsula) than elsewhere. The gillnet catch rates for 2009 were not markedly different from recent values and were lower than those in most of the time series (Fig. 12b). For line-trawl, most data comes from areas west of the Burin Peninsula and the results areas 29-33 are based on fewer data (generally <50 sets per year) and show more annual variability. Line-trawl catch rates in 2009 were generally good across 3Ps, yet slightly less from those of the past few years.

Prior to modeling, the data were aggregated within each gear-year-month-location cell, and the aggregated data were weighted by its associated cell count. Catch per unit effort (CPUE) data were standardized to remove site (fishing area) and seasonal (month, year) effects. Note that sets with effort and no catch are valid entries in the model.

In the present assessment, the model adequately fitted data from gillnets and line-trawls and two standardized annual catch rate indices were produced, one for each gear type. All effects included in the model were significant.

Standardized gillnet catch rates declined over 1998-2000 and have subsequently been low but stable at approximately 20kg/net (Fig. 12c). For line-trawls, catch rates declined from 300 kg/1000 hooks in 1997 to a minimum of about 200 kg/1000 hooks during 2002. Values for 2003 to 2006 were progressively higher and the 2006 value is the largest estimated catch rate at 353 kg/1000 hooks. Subsequently, catch rates have declined, and the 2009 value of 245 kg/1000 hooks is slightly below the time-series average.

The observed trends in commercial catch rate indices for the inshore fishery are influenced by many factors. There have been substantial annual changes in the management plans in the post-moratorium period (Brattey et al. 2003). In addition, catch rates from mobile commercial fleets can be related more to changes in the degree of local aggregation of cod and can be a poor reflection of overall trends in stock abundance, particularly for stocks in decline. While this is likely to be a bigger problem with respect to otter-trawl derived catch rates, gillnets and line-trawls can also be deployed to target local aggregations. For inshore fisheries, catch rates can also be strongly influenced by annual variability in the extent and timing of inshore as well as long-shore cod migration patterns. Similarly, the changes in management regulations, particularly the switch from a competitive fishery to IQs and for some vessels the need to fish cod as by-catch to maximize financial return, can have a strong influence on catch rates that is unrelated to stock size (DFO 2006). Consequently, inshore commercial catch rate data must be interpreted with caution. Despite these issues, the initial declines in gillnet and line-trawl catch rates following the re-opening of the fishery in 1997 were cause for concern. The recent decrease in modeled catch rates for line-trawls since 2006 may in part be reflecting the reduced availability of the 1997 and 1998 year classes in the inshore catch, as the numbers of fish in these cohorts decline. Close inspection of the commercial catch numbers-at-age data has shown that the proportion of cod age 7 and older in the linetrawl catch has increased over 2002-09. Modeled gillnet catch rates have shown no significant changes in recent years.

INDUSTRY LOGBOOKS (>35 ft sector)

Median annual catch rates by gear sector and unit area from log books of larger vessels (>35 ft sector) were not available for this assessment as data analysis could not be completed prior to the assessment meeting. Recent trends were documented by Healey et al. (2011a), and it is expected that this data set will be studied further in future assessments.

TAGGING EXPERIMENTS

A project involving tagging of adult (>45 cm) cod initiated in 1997 has continued through 2010. The purpose of the tagging study is to provide information on movement patterns of 3Ps cod as well as obtain ongoing estimates of exploitation rates on different components of the stock. However, for several reasons, tagging efforts in 3Ps have been much reduced over the 2004-10 period. In particular, tag releases in 2008-10 have been limited to Placentia Bay only. In contrast to previous years, it is no longer possible to estimate tagging-based exploitation rates across most of the stock area. A brief synopsis of current results and details from previous years are provided below; computational details are provided in Brattey and Healey (2006).

ESTIMATES OF EXPLOITATION (HARVEST) RATE

The methods used to estimate average annual exploitation rates (harvest rates, in percent) for cod tagged in different regions of 3Ps are described in detail previously (Brattey and Cadigan 2004; Brattey and Healey 2003, 2004, 2005, 2006; Cadigan and Brattey 2003, 2006, 2008). During 2001-05, the mean exploitation rate was relatively high for cod tagged in Placentia Bay (3Psc, 22-31 %)

compared to those tagged in Fortune Bay (3Psb, 10-12 %), Burgeo Bank/Hermitage Channel (3Psd, 1-8 %) or offshore in Halibut Channel (3Psg/h, 2-6 %), respectively. Estimation of inshore exploitation during 2006 and 2007 was hampered by insufficient numbers of releases. Although estimates of inshore exploitation rates from the 2006 fishery were reported by Brattey et al. (2007), they noted that due to the lapse in inshore tagging during 2004-2006, these rates were only partial estimates. During 2008, estimates of mean exploitation rate for cod tagged in Fortune Bay and Placentia Bay were approximately 10 %. However, tagging was conducted only in the western part of Placentia Bay in 2007, and thus the 2008 exploitation rates for Placentia Bay may not be comparable to those from previous years when tagging was more widespread.

Results on size-specific exploitation rate from recent releases showed that although exploitation has been low in Placentia Bay, exploitation rate increases considerably with fish length, particularly for those sizes which are fully selected by the fishery (approximately 65 cm). Exploitation rates were compared for all fish >45 cm, >55 cm, and for all releases >65 cm. In 2008, exploitation rates corresponding to these size classes were 7 %, 9 % and 13 % respectively. Corresponding results for 2009 were 9 %, 15 %, 36 %, respectively. Despite the substantial change with size, none of the values appear to be excessively high. It is cautioned that the exploitation rates for 2009 corresponded to tagging activity shortly before the 2009 fishery with limited time for dispersal of tagged fish which likely biases the estimated exploitation.

Tagging in the offshore (unit area 3Psh) was last conducted in 2005, and exploitation rates can be estimated – and compared – throughout 1998-2007. Exploitation rates estimated from tagging in Halibut Channel from 2005-07 increased compared to previous estimates. The 2005-07 exploitation estimates were about 8 % per year, compared to estimates of 2-3 % over 1997-2004.

These low offshore exploitation rates in spite of substantial offshore landings are consistent with a large offshore biomass in relation to the magnitude of recent offshore catches. However, the offshore estimates of exploitation are considered uncertain because of the limited timing and localization of offshore tagging coverage and restricted distribution of fishing activity in the offshore. There is also greater uncertainty in the reporting rates of tags from the offshore, and in the survival of fish caught and released after tagging offshore in deep (>200 m) water. The estimates of exploitation from offshore tagging experiments reported above assume that 40 % of tagged cod succumb post-tagging; this estimate is based on direct estimates from acoustically tagged cod captured with otter trawls at depths of 200m.

With respect to migratory patterns and stock distribution, the tagging results of 2007-2010 generally agree with previous findings (Brattey et al. 2001, 2002; Brattey and Healey 2004, 2005, 2006), and indicate restricted mixing of cod from different portions of the 3Ps stock area. The limited mixing of inshore cod in particular make it difficult to determine whether inshore indices are reflecting trends in the stock as a whole or mainly of inshore components of the stock. Trends in the indices differ between inshore and offshore and are difficult to reconcile with the tagging results. Tagging suggests lower exploitation in the offshore than most inshore areas, yet the DFO RV declined for several years over 2001-08. In contrast, inshore indices (sentinel) have been stable for several years (albeit at a lower level than when the fishery opened in 1997), whereas tagging suggests that in some inshore areas such as Placentia Bay exploitation was relatively high (~25 %) for several years. The discrepancy between trends in inshore/offshore abundance indices and tagging estimates of exploitation was previously noted in recent assessments and remains enigmatic and difficult to explain.

RESEARCH VESSEL SURVEY

Stratified-random surveys have been conducted in the offshore areas of Subdiv. 3Ps during the winter-spring period by Canada since 1972 and by France over 1978-92. The two surveys were similar

with regard to the stratification scheme used, sampling methods and analysis, but differed in the type of fishing gear and the daily timing of trawls (daylight hours only for French surveys). Canadian surveys were conducted using the research vessels *A. T. Cameron* (1972-82), *Alfred Needler* (1983-84; 2009-10), and *Wilfred Templeman* (1985-2008). From the limited amount of comparable fishing data available, it has been concluded that the three vessels had similar fishing power and no adjustments were necessary to achieve comparable catchability factors, even though the *A.T. Cameron* was a side trawler. Cadigan et al. (2006) found no significant differences in catchability for several species, including cod, between the *Wilfred Templeman* and *Alfred Needler* research vessels. The French surveys were conducted using the research vessels Cyros (1978-91) and Thalassa (1992) and the results are summarized in Bishop et al. (1994).

The Canadian research vessel surveys from 1983 to 1995 employed an Engel 145 high-rise bottom trawl. In 1996, research surveys began using the Campelen 1800 shrimp trawl. The Engel trawl catches for 1983-95 were converted to Campelen 1800 shrimp trawl-equivalent catches using a length-based conversion formulation derived from comparative fishing experiments (Warren 1996; Warren et al. 1997; Stansbury 1996, 1997).

The stratification scheme used in the DFO RV bottom-trawl survey in 3Ps is shown in Fig. 13. Canadian surveys have covered strata in depth ranges to 300 fathoms since 1980. Five new inshore strata were added to the survey from 1994 (stratum numbered 779-783) and a further eight inshore strata were added from 1997 (293-300) resulting in a 12 % increase in the surveyed area. Beginning in the 2007 assessment, new indices using survey results from the augmented survey area were presented for the first time. Two survey time series can now be constructed from the catch data from Canadian surveys. To avoid confusion, throughout this document as well as the Science Advisory Report from the 2010 assessment meeting (DFO, 2010), the index from the expanded surveyed area that includes new inshore strata is referred to as the "all strata <300 fms" index and the time series extends from 1997 onwards, whereas the original smaller surveyed area is referred to as the "offshore" survey and the time series that incorporates a random stratified design extends from 1983-present.

The results (in Campelen or Campelen-equivalent units) for the entire survey area are summarized by stratum in terms of numbers (abundance) (Table 9) and biomass (Table 10), for the period 1983-2010. The timing of the surveys, number of sets fished, and vessels used are proved in the table header. Fig. 14 illustrates both the number of days taken to complete the survey of subdivision 3Ps, and also number of survey sets completed each year. Due to extensive mechanical problems with the research vessel, the survey in 2006 was not completed: only 48 of 178 planned sets were completed. Also, the 2008 and 2009 spring surveys took considerably longer to complete than most other years. In the tables of results, strata for which no samples are available were filled in using a multiplicative model (excluding 2006 survey results). The timing of the survey has varied considerably over the period. In 1983 and 1984 the mean date of sampling was in April, in 1985 to 1987 it was in March, and from 1988 to 1992 it was in February. Both a February and an April survey were carried out in 1993; subsequently, the survey has been carried out in April. The change to April was aimed at reducing the possibility of stock mixing with cod from the adjacent northern Gulf (3Pn4RS) stock in the western portion of 3Ps. The stock mixing issue is described in more detail in previous assessments (e.g., Brattey et al. 2007).

ABUNDANCE, BIOMASS, AND DISTRIBUTION

A time series of trawlable abundance and biomass indices from DFO random stratified RV offshore survey is given in Fig. 15. The abundance and biomass index estimates from the 2010 survey were 88.5 million fish and 57.4 Kt. In the 2010 survey there was no major change in the distribution of survey catches. The strata with the largest catches in terms of biomass were 319 and 323 (together, these strata cover much of the Halibut Channel) and 308 (a portion of Burgeo Bank). Combined, these strata accounted for 65 % of the biomass index and 54 % of the abundance index for 2010. Although it

is common for results from the Halibut Channel to comprise a significant fraction of the overall survey abundance and biomass results, mostly due to results from stratum 319, it is atypical to have large contributions from stratum 323 (north of stratum 319). In 2010, this stratum comprised 16 % and 17 % of the survey abundance and biomass, respectively, compared to average annual contributions of 3 % and 2 %.

Trends in the abundance index and biomass index from the RV survey are shown for the offshore (i.e., index strata only: those strata of depth less than or equal to 300 fathoms, excluding the new inshore strata) and the all strata area (Fig. 15). Survey indices of cod in 3Ps are at times influenced by "year-effects", an atypical survey result that can be caused by a number of factors (e.g., environmental conditions, movement, degree of aggregation, etc.) which may be unrelated to absolute stock size. The time series for abundance and biomass from 1983 to 1999 show considerable variability, with strong year effects, for example, the 1995, 1997 and 1998 surveys compared to those from adjacent years. The 1995 estimate is influenced by a single large catch contributing 87 % of the biomass index and therefore has a very large standard deviation. The 1997 survey values were the lowest observed in the time series, which goes back to 1983, being less than half of the 1996 index. The size composition of fish in the 1997 RV survey suggested that this survey did not encounter aggregations of older fish, yet these fish were present in the 1996 survey and in subsequent commercial, sentinel, and survey catches. It is also likely that either the 2008 or 2009 results (possibly both results) include year-effects. The nature of the difference between the 2008 and 2009 survey results are discussed in detail in the "Age Composition" section below.

The minimum trawlable abundance index declined from 88.2 million in 2001 to 38.7 million in 2008, the longest period of consistent decline in the entire time-series. However, the index has more than doubled since 2008 with the 2010 estimate being comparable to the result of 2001. The minimum trawlable biomass estimate has been variable for much of the post-moratorium period, but as with abundance, the biomass index generally declined over 2001 to 2008. The biomass index also increased considerably between 2008 and 2009, from 20.5 Kt to 56.0 Kt – approaching a three-fold increase. In contrast to continued increases in abundance, the biomass index in 2010 remains virtually unchanged from that in 2009. Detailed trends in trawlable abundance and biomass are generally difficult to discern from the survey indices due to high intra-annual variability. Excluding the 1995 and 1997 survey results would suggest the time series of biomass estimates can be broadly divided into three periods – highest during 1983-90, lowest during 1991-97, and intermediate to low values during the most recent period 1998-2009. The trends and degree of variability in the combined inshore/offshore survey are almost identical to those of the offshore survey in spite of the 12 % increase in surveyed area; the only exception is in 2004 when the combined inshore/offshore survey shows higher biomass and abundance due mainly to a large estimate from inshore stratum 294 (see Tables 9 and 10).

The survey results are also provided in terms of catch rates (i.e., mean numbers per tow) for the offshore (since 1983) and all strata (since 1997) survey indices (Fig. 16). The trends are identical to the abundance index described above.

To investigate whether there have been annual shifts in the distribution of the stock at the time of the survey, trends in the proportion of the total abundance observed in three different regions of the stock area were compared (Fig. 17); the areas were: the inshore (strata 293-298, and 779-783), the Burgeo area (Hermitage strata 306-309, and 714-716), and the eastern area (remaining strata). Data from the combined inshore/offshore survey were used and the Campelen trawl was fished in all these surveys. The proportions were variable, with typically 30-70 % observed in the larger eastern area, 20-60 % in the western area, and around 10 % in the inshore area; an exception was 2005 when almost 40 % of the total abundance index was observed in the inshore, again due to a large estimate for inshore stratum 294. Much of this variation is resultant from year effects, e.g. the value for 1998 is high due to several large catches on Burgeo Bank and vicinity that may have included fish from the neighbouring

northern Gulf (3Pn4RS) cod stock. The age-aggregated surveys in recent years do not give any strong indications of a significant influx of cod from the neighbouring 3Pn4RS stock.

The spatial distribution of catches of cod during the 2010 survey was examined, for all ages combined (Fig. 18a, includes 2007 to 2009 for comparison) and separately for ages 1-12 (Fig. 18b to 18d). Previously it has been demonstrated (Healey et al. 2011a, Brattey et al. 2007) that during 1999-2009 cod were caught over a considerable portion of NAFO Subdiv. 3Ps with the largest catches typically in the southern Halibut Channel area, on Burgeo Bank and vicinity, and in the outer portion of Fortune Bay. During these years cod were consistently scarce in the deep water below the mouth of Placentia Bay and in the inner reaches of Hermitage Channel.

Distribution plots of age-disaggregated survey catches from the 2010 survey (Figs. 17b-d) indicate that relatively small catches of 1 yr old cod were measured across much of the survey area where cod are typically found. Due to their small size, one-year old cod are not fully selected by the trawl. Cod aged 2 yrs old were encountered more frequently, with larger catches taken along the southern edge of the Hermitage Channel. Cod ages 3 and 4 yrs old were found over most of the surveyed area, with the relatively large catches of these age groups taken on Burgeo Bank, along the southern edge of the Hermitage Channel and also within the Halibut Channel. The magnitude of the of catches of cod aged 5-9yr old in 2009 decrease considerably with age, and excluding one relatively large tow on the southwestern corner of St. Pierre Bank, only small catches of these age groups were found outside of Burgeo Bank, the Hermitage Channel or the Halibut Channel. Catches of cod in 2010 aged 10 or older were infrequent and far fewer fish were caught than in the recent past. Catches of these older fish are almost exclusively within the Halibut Channel.

AGE COMPOSITION

Survey numbers at age are obtained by applying an age-length key (ALK) to the numbers of fish at length in the samples. The current sampling design for cod in Subdiv. 3Ps requires that an attempt be made to obtain 2 otoliths per one cm length class from each of the following locations: Northwest St. Pierre Bank (strata 310-314, 705, 713), Burgeo Bank (strata 306-309, 714-716), Green Bank-Halibut Channel (strata 318-319, 325-326, 707-710), Placentia Bay (strata 779-783) and remaining area (strata 315-317, 320-324, 706, 711-712). This spatial stratification ensures sampling is distributed over the surveyed area. The otoliths are then combined into a single ALK and applied to the survey data. The resulting estimates of age-disaggregated mean numbers per tow are given in Table 11a. These data can be transformed into trawlable population abundance at age by multiplying the mean numbers per tow at age by the number of trawlable units in the survey area. This is obtained by dividing the area of the survey by the number of trawlable units. For the "offshore" survey in 3Ps, the survey area is 16,732 square nautical miles including only strata out to 300 ftms (and excluding the relatively recent inshore strata added in 1997). The swept area for a standard 15 min tow of the Campelen net is 0.00727 square nautical miles. Thus, the number of trawlable units in the 3Ps survey is $16,732 \div 0.00727 = 2.3 \times 10^{6}$.

The mean numbers per tow at age in the DFO RV survey for the "offshore" index is given in Table 11a and results for ages 1-15 are shown the form of standardized "bubble" plots in Fig. 19. Cod up to 20 years old were not uncommon in survey catches during the 1980's, but the age composition became more contracted through the late 1980s and early 1990s. Prior assessments of this stock (e.g., Brattey et al. 2007) focused upon the 1997 and 1998 year-classes which were relatively strong and contributed significantly to commercial catches for several years. However, in the 2010 survey, the 1997 and 1998 year-classes provide only a marginal contribution to survey totals. Several year-classes subsequent to the 1997 and 1998 year-classes - specifically the 1999 through 2005 year-classes - are relatively much poorer. In the 2010 survey, the number of fish age 7 and older (includes most of these poorer year-classes) was amongst the lowest since 1997. The 2006 year-class, however, has been above average in each of the 2007-10 surveys, and is largely responsible for the

considerable increase in the abundance index since 2008. Data thus far for the 2007 year-class indicates it is of average strength. A more quantitative analysis of recruitment is given later.

Overall, the age composition of survey catches has expanded in recent years with ages up to 17 yrs represented; however, the age structure remains somewhat contracted relative to the mid-1980s with presently very few fish older than age 15.

SIZE-AT-AGE (MEAN LENGTH AND MEAN WEIGHT)

The sampling protocol for obtaining lengths-at-age and weights-at-age has varied over time (Lilly 1998), but has consistently involved stratified sampling by length. For this reason, calculation of mean lengths and weights included weighting observations by population abundance at length (Morgan and Hoenig 1997), where the abundance at length (3-cm size groups) was calculated by areal expansion of the stratified arithmetic mean catch at length per tow (Smith and Somerton 1981). Only data from 1983 onward are presented.

The mean length-at-age time series is updated using the 2010 survey data (Table 12; Fig. 20a). For ages older than age 4 there was a decline in length-at-age from the early 1980s to the mid-1990s. There was an increase in length-at-age from the mid-1990s through the mid-2000s over most ages, but data from 2007 to 2010 surveys suggest that mean length at age for ages 3-5 has been lower since.

Annual variation in mean length at age was examined by analyzing deviation from the average over the time series for each age. The average mean length at age from 1983 to 2010 was calculated for each age. Deviation was calculated for each age in each year by subtracting the mean for the age for the time series from the annual observation for that age. These deviations were examined for a significant year effect using year as a class variable in a general linear model. Ages 3 to 9 were included. There was significant interannual variation in the deviation from mean length at age ($F=3.6$, $df=26,188$, $p<0.0001$, $r2=0.37$). Mean length at age was greater than average in the mid 1980s. It showed a declining trend until the mid 1990's when it was below average. Mean length at age subsequently increased and has been variable since 1999 or 2000 (Fig. 20b). Multiple comparisons based on least squares means were used to determine which years were significantly different. Deviations in 1994-96 were significantly lower than those over all years from 1983-1989. In the recent period, 2008 was significantly lower than 1983-89 and 2009 was significantly lower than 1983-85, but 2010 was not different from these early years, even though mean length at ages 5 and 6 is considerably lower in 2010 than the length for those ages in the mid 1980s.

Values for mean weight at age from the 2010 survey were computed. As expected, the patterns in mean weight-at-age (Table 13; Fig. 21a) appear to be very similar to those in length-at-age. For cod ages 5 and older, there was a decline in weight-at-age from the early 1980s to the mid-1990s (Fig. 21a). For all age groups, there was an increase in weight-at-age from the mid-1990s through the mid-2000s, but data from 2007 to 2010 surveys suggest that mean weight-at-age has been lower than the mid-2000's.

There was significant interannual variation in the deviation from mean weight-at-age ($F=2.6$, $df=26,188$, $p<0.0001$, $r2=0.30$). Mean weight-at-age was greater than average in the mid 1980s (Fig. 21b). Deviation in mean weight-at-age is more variable than in mean length-at-age. The lowest mean weights-at-age were observed in 1994-95 and these were significantly different from 1983 to 1986. As with mean length-at-age, mean weights-at-age increased after that time and have been variable since 1999 or 2000. In recent years, 2008 had lower mean weight-at-age than the 1983-86 period but 2009 and 2010 were not different from that period.

CONDITION

The somatic (gutted) condition and liver index of each fish were calculated from survey data and expressed using Fulton's condition factor ($W/L3*10^5$), where W is gutted weight (kg) or liver weight (kg) and L is length (cm). Since Fulton's condition factor is not independent of length, data are presented by length group. It has been shown that the timing of the survey affects estimates of condition for 3Ps cod (Lilly 1998) and so only estimates from April surveys beginning in 1993 are presented in Figs. 22 and 23. Both somatic and liver condition generally increased until 1998 and were lower until the early 2000's. The 2008-10 estimates are among the lowest in the time series (Fig. 22).

Another way to examine condition without an effect of length is to calculate relative condition (relative K). A length gutted weight relationship was estimated, and the condition index is then observed condition divided by the condition predicted from the length weight regression for a fish of that length. Relative liver condition (relative LK) was calculated in a similar fashion using a liver weight length regression. Relative condition shows the same general trend as Fulton's condition factor for somatic and liver weight, with condition increasing until 1998, followed by a period of lower condition up until 2004 and very low condition in 2008-10 (Fig. 23). There was a significant year effect for both relative LK (χ^2=508, df=16, p<0.001) and relative K (χ^2=224, df=16, p<0.001; results of generalized linear models with gamma error and identity link). Estimates of relative K in 2008-10 are significantly lower than estimates from the late 1990's and mid 2000's. Estimates of relative liver condition in 2010 are lower than all but those from 1993-1994, and estimates from 2008 are lower than all but 1995. These results indicate that condition in recent years has been low compared to most of the years since 1993.

MATURITY AND SPAWNING

The sampling design used to gather biological data to study maturation trends and an overview of recent maturity and fecundity research relating to 3Ps cod can be found in Brattey et al (2008).

Annual estimates of age at 50 % maturity (A50) for females from the 3Ps cod stock, collected during annual winter/spring DFO RV surveys, were calculated as described by Morgan and Hoenig (1997). Trends in age at 50 % maturity are shown in Fig. 24a (only cohorts with a significant slope and intercept term are shown); parameter estimates and associated standard errors for the 1954 to 2005 cohorts are given in Table 14 and the model did not adequately fit the data from subsequent cohorts as most of these fish remain immature. The estimated A50 was generally between 6.0 and 7.0 for cohorts from the mid-1950s to the early 1980s, but declined dramatically thereafter to 5.1 in the 1988 cohort (Table 14, Fig. 24a). A50 has remained at this lower level, with the exception of the 2003 cohort for which A50 is 5.8 years old. Given that the estimation is by cohort, estimates for the most recent cohorts may be revised slightly in future years as additional data is collected. Males show a similar trend in A50 over time (data not shown), but tend to mature about one year earlier than females.

Annual estimates of the proportion mature at age are shown in Table 15; these were obtained from the cohort model parameter estimates in Table 14. The estimates of proportion mature for ages 4-7 show a similar increasing trend (i.e., increasing proportions of mature fish at young ages) through the late 1970s and 1980s, particularly for ages 5, 6, and 7 (Fig. 24b). The current proportion mature at age remains high; however, the effect of increased A50 for the 2003 cohort, which equates to reduced proportion mature at age, is evident.

The time series of maturities for 3Ps cod shows a long-term trend as well as considerable annual variability. Such variations can have substantial effects on estimation of spawner biomass. Further, the age composition of the spawning biomass may have important consequences in terms of producing recruits (see Brattey et al. 2008).

Cod in 3Ps appear to spawn over a significant portion of the year and at many locations within the stock area. Spawning is spatially widespread and is known to occur on Burgeo Bank, St. Pierre Bank, and the Halibut Channel area, as well as inshore in Hermitage Bay (3Psa), Fortune Bay (3Psb) and Placentia Bay (3Psc). Spawning in Placentia Bay has been studied more intensively than elsewhere in 3Ps (Bolon and Schneider 1999; Lawson and Rose 1999; Bradbury et al. 2000).

GEAC STRATIFIED RANDOM TRAWL SURVEY

During fall 1997-2005, trawl surveys were conducted by the Groundfish Enterprise Allocation Council (GEAC) using an un-lined commercial trawl. These surveys are carried out in late fall and cover a large portion of offshore 3Ps, but not the Burgeo Bank area. Detailed results of these surveys are reported in McClintock (1999a, 1999b, 2000, 2001, 2002, 2003). During the fall of 2007, a new survey was conducted using a lined shrimp trawl and altered tow protocol from previous surveys and hence the 2007 results are not comparable with previous estimates (see McClintock, 2011). Results from this survey (to 2005) are used in conjunction with data from the DFO RV index to estimate trends in recruitment.

COHORT ANALYSES

During the 2006 assessment of this stock, it was agreed that sequential population analyses of 3Ps cod should be discontinued, primarily due to inconsistent trends in the index data available (poor correlations within and between surveys), poor model fit (strong year-effects and poor precision in estimated parameters). (For additional discussion, refer to DFO (2006, 2007) as well as Brattey et al. 2007.) In addition, during assessment meetings concerns have been expressed regarding the accuracy of the total landings captured by the commercial catch data (e.g., DFO 2010). In the 2007 assessment of this stock, Brattey et al. (2008) provided estimates of instantaneous rates of total mortality (Z) for 1997-2007 as computed directly from the combined DFO RV survey. A debate on smoothing these annual estimates of total mortality during the winter 2009 zonal assessment meeting lead to the exploration of cohort modeling of the survey data to provide structure to the smoothing. Consequently, a survey-based model based upon the work of Cook (1997) was implemented and provides estimates of total mortality, relative recruitment strength, and relative estimates of total and spawning biomass from the DFO RV survey (see Cadigan 2010).

The age-disaggregated cohort model assumes that total mortality experienced by the population can be separated into vectors of age effects s_a and year effects f_y (such that $Z_{a,y} = s_a \times f_y$). Estimation (lognormal) minimizes the difference between the predicted and observed survey index over all ages and years, with penalties applied to impose a degree of smoothing on the estimated age and year effects. However, the model was speculative in that it could not reliably estimate survey catchability and this is fixed at scenario values. Detailed model specification, sensitivities of results to modeling assumptions, and estimation procedures applied during both the zonal and regional assessment meetings of 2009 are documented in Cadigan (2010). PROC NLMIXED in SAS/STAT™software is used to estimate parameter values and associated uncertainty. Data for ages 1-12 from the DFO RV expanded index were used, including an adjustment for the 1983-96 survey indices to account for the inshore area that was not sampled in these years. However, data for ages 1 and 2 over 1983-1995 are zero-weighted in estimation, due to concerns of potential biases in RV data conversion of these age groups. (This conversion accounts for a change in the trawl gear after the 1995 survey.) Results of two analyses which assumed different selectivity patterns (i.e., "domed" and "flat-top" selection), indicated that the estimated survey SSB decreased in recent years such that in 2009 survey SSB was only marginally above the limit reference point (the 1994 level of spawning biomass). Estimates of total mortality for ages 4-11 over 2004-2008 were approximately 0.55 (42 % mortality). This value represents the average of the mortality across the two model results evaluated.

An update run using the same model structure was presented. However, it was agreed during the assessment that only a flat-topped selectivity analysis would be reported, as it was argued that best-practice is to assume flat-topped selectivity (Northeast Fisheries Science Center, 2008) unless there is evidence otherwise. Model diagnostics are similar to results obtained during the previous assessment. Estimated survey SSB relative to B_{lim} from the updated run is consistent with those from the previous assessment, and indicate a considerable decline in survey SSB over 2003-2009. The estimate of 2010 survey SSB in the update run indicates a slight increase compared to the 2009 estimate, with the median SSB estimated to be marginally above the LRP. Estimates of mortality in recent years are higher compared to the previous assessment (see Appendix 1). Necessarily, estimated recruitment is also higher so that sufficient numbers of individuals remain after being subjected to the high mortality in order to yield predictions survey indices that match observed values.

Due to minor residual patterns for the youngest ages (not shown), an additional flat-topped selectivity run was conducted with an alternate set of catchability parameters. The age effects estimated in deriving a recruitment index from the age 1-4 survey data (details in next section) were used to provide some objectivity in the survey catchabilities supplied to the model. In this final run, cod ages 4 and older are assumed to be fully selected by the RV survey gear. Results using these selectivity parameters are similar to previous analysis with a decrease in SSB from the mid-2000's to 2009 (Fig. 25). The estimated SSB for 2010 is slightly improved over the 2009 estimate, with the median SSB being 1.07 times the LRP. Estimates of total mortality (Fig. 25) show consistent increase over 1997-2009, and mortality over 2005-09 (ages 4-11) averaged 0.60 (45 % mortality). This high level of mortality is a concern. Total mortality rates reflect mortality due to all causes, including fishing. The scale of recruitment estimates are impacted by changes to the assumed catchabilities noted above; yet results agree with previous analyses in that the 2006 year-class is much stronger than several prior year-classes (Fig. 25). Model diagnostics show evidence of the year-effects described in the survey results section, otherwise there are no indications of systematic model fit issues (Fig. 26). Detailed output of estimation and model results is provided in Appendix 1.

Survey population estimates to 2011 were conducted assuming total mortality rates were similar to current values (i.e., within +/- 20 %). Recruitment was assumed to be the geometric mean of the age 1 estimates over 2008-10, and weights at age were assumed to equal the average of those over 2008-10. The proportions mature at age were projected forward from the cohort-specific model estimates. Five projection scenarios were conducted, using multipliers of 0.8, 0.9 1.0, 1.1, and 1.2 current Z. Under each of these scenarios, survey SSB increases - the probability of being below the LRP in 2011 ranged from 0.04 if mortality is reduced by 20 %, to 0.17 should total mortality increase by 20 % from current levels.

RECRUITMENT INDEX

A multiplicative model was used to estimate the relative year class strength produced by the 3Ps spawning stock as indicated from trawl survey indices (mean numbers per tow at age). During the 2007 assessment (Brattey et al. 2008), it was decided that it would be inappropriate to include all of the available indices because of the different trends and uncertainty as to whether the available indices were indicative of trends in the stock as a whole or only portions of it. The input data used was restricted to:

i)   GEAC mean numbers per tow data, 1998-2005 for ages 3 and 4, and

ii) DFO RV survey (all strata <300 fms) mean numbers per tow during 1997-2005 and 2007-10, including ages 1-4.

Only year-classes with two or more observations were considered in the analysis, yielding estimates of relative strength for the 1994-2008 year-classes.

On a log-scale the model can be written as:

$$\log(I_{s,a,y}) = \mu + Y_y + (SA)_{s,a} + \varepsilon_{s,a,y},$$

where:

μ = overall mean
s = survey subscript
a = age subscript
y = year class subscript
I = Index (mean nos. per tow)
Y = year class effect
SA = Survey * Age effect, and
ε = error term.

Estimation of model parameters was conducted using PROC MIXED in SAS/STAT™ software. The input data were equally weighted. Each of the model terms (year-class and survey-age) were significant in all analyses. Estimated least-squares means for the 1994-2007 year-classes (Fig. 27) can be split into two categories: the 1997, 1998 and 2006 year-classes are all estimated to be at least three times stronger than all other cohorts. The relative strength of the 2008 year-class, based upon the age 1 result from the 2009 survey and the age 2 data from the 2010 survey, appears to be intermediate between the two groupings noted above.

Previous analyses that incorporated a longer time-series of data from the DFO RV survey of the offshore showed that recruitment, though variable, was generally higher in the 1980's (e.g., Brattey et al. 2007). The 1997 and 1998 year-classes strongly contributed to commercial fisheries for several years, but presently, the fishery is mainly reliant on the 1999-2005 year-classes, all of which are relatively weaker. The confirmation of a strong recruiting year-class (2006 year-class) from the survey data is significant as it follows several successive below-average year-classes. If the 2006 year-class remains above average it should contribute strongly to both the fishery as well as the spawning stock biomass.

Some information on the relative strength of recent year-classes is also available from the sentinel line-trawl index. This index covers an inshore portion of the stock area shoreward of the trawl surveys. The age-disaggregated sentinel line trawl index (Table 8, Fig. 11b) provides evidence that most year classes produced during 2000-02 are weaker than the 1997 and 1998 year classes. The 2004 year-class is also above-average in this index, which is inconsistent with the results based upon RV data only. Information on the 2006 year-class is not yet available from the sentinel indices.

CONCLUSONS AND ADVICE

The assessment concluded from tagging data and ancillary information that the complex of stock components exploited by fisheries in 3Ps does not comprise a single stock for which population biomass and abundance can be estimated from existing information. Therefore the impacts of fishing at specific TAC levels on all stock components could not be quantified. However, the DFO RV survey covers most of the stock, and survey trends broadly reflect stock trends. Indices based on the research vessel (RV) survey have been used to assess current status of the stock relative to historic observations and to evaluate growth and sustainability of the stock.

A limit reference point (LRP, BRecovery) was identified for this stock during the 2004 assessment (DFO 2004). It is defined as the lowest observed spawning stock biomass (SSB) from which there has been a sustained recovery; the 1994 value of SSB has been identified as the LRP. Estimated survey

SSB from a cohort model (SURBA) decreased in recent years and in 2008 and 2009 were below the limit reference point (LRP) with probability of 0.59 and 0.75, respectively. The survey SSB in 2010 is estimated to be above the LRP, although the probability of being below the LRP is 0.37. A one year projection to 2011 using the cohort model indicated that survey SSB will increase if total mortality rates are similar to current values (i.e., within ±20 %), and that the probability of being below the LRP in 2011 is low (0.04 to 0.17). It was not possible at present to relate the level of catch to estimated total mortality.

The 2006 cohort is estimated to be relatively strong and is expected to recruit to the 2011 fishery. The 2007 and 2008 cohorts are estimated to be near the 1994-2008 average. Year-classes currently supporting the fishery are relatively weak in comparison to the strong 1997 and 1998 cohorts. Fish harvesters indicate the 2006 cohort is beginning to recruit to the fishery.

Estimates of total mortality (ages 4-11) from a cohort model over 2005-09 were approximately 0.60 (45 % mortality). This high level of mortality is a concern. Total mortality rates reflect mortality due to all causes, including fishing.

The status of inshore components is uncertain. The inshore fishery exploits a mixture of inshore stock components and migrants from the offshore. Exploitation rates for cod tagged in Placentia Bay during 2008 and 2009 ranged from (10-14 %) and were lower than those observed in 1999-2005 (23-35 %). The commercial gillnet catch rates for the <35' fleet and both sentinel catch rate series (gillnet and linetrawl) are stable. The commercial linetrawl catch rates for the <35' fleet have decreased in recent years.

Overall, the findings of the current assessment are consistent with those of previous assessments. The 3Ps cod SSB at the beginning of 2010 was estimated to be marginally above the LRP.

OTHER CONSIDERATIONS

Management Considerations

The implementation of trip limits, price differentials based on size, and individual quotas (IQ's), are all potential incentives for discarding and high-grading of catches. Recent investigations into this problem have identified that high-grading has occurred, but the quantity has not been determined. Quantifying discards would improve the understanding of stock productivity. This is an unaccounted source of fishing mortality.

Management should recognize that cod which overwinter in 3Ps are also exploited in adjacent stock areas (Div. 3L and Subdiv. 3Pn). Hence management actions in these stock areas should consider potential impacts on 3Ps cod.

Recent results confirmed that closures to protect spawning or mixed-stock aggregations are appropriate.

Consequences of area/time closures should be carefully considered as these may result in higher exploitation rates on the components of the stock that remain open to fishing. The fishery should be managed such that catches are not concentrated in ways that result in high exploitation rates on any stock components.

Management should be aware of within-year variations in the individual weight of cod. Greatest yield can be gained when fish are in peak condition, typically in late fall/early winter, while minimizing the number of individuals removed from the stock.

The level of total removals is uncertain. In assessing stock status, it would be useful to better understand the accuracy of total removals, especially in the post-moratorium when commercial catches are more strictly monitored. Accurate estimates of recreational fishery landings are also required.

Temperature

Oceanographic information collected during the spring DFO RV surveys indicated that near-bottom temperatures throughout NAFO Subdiv. 3Ps have warmed in both 2009 and 2010, increasing to above normal values. For example, the area of <0 °C water has decreased to about 10 %, compared to almost 30 % in 2007 and 2008. Survey catches of cod are generally lower in years when there are relatively large incursions of cold/fresh water from the eastern NL shelf. The areal extent of bottom water with temperatures >3 °C has remained relatively constant at about 50 % of the total 3P area, although actual temperature measurements show considerable inter-annual variability. The current conditions are comparable to those of the late 1970's and early 1980's when the stock was more productive.

Sources of Uncertainty

The level of total removals is uncertain. It is likely that historical landings have been biased both upwards (e.g., due to misreporting of catch by area and/or species) and downwards (e.g., due to discarding). In addition, commercial catch accounting procedures pre- and post-moratorium are radically different, with current measures likely to provide improved estimates of removals. In assessing stock status, it would be useful to better understand the accuracy of total removals, especially in the post-moratorium. Estimates of recreational fishery landings have not been provided for 2009.

There is uncertainty regarding the origins of fish found in 3Ps at various times of the year. Tagging and telemetry experiments show that there is mixing with adjacent stocks (southern 3L and 3Pn4RS) and this may vary over time. This may contribute to unusual year-to-year variability in survey indices.

Comparison of sentinel catch rates and the DFO RV index at times show inconsistent age-compositions. This may be indicative of differences in cohort strength between stock components. For example, the sentinel gillnet data consistently measured the 1992 cohort as being an above average fraction of the annual catch. This cohort was also important to the commercial gillnet catch, but was not notable in the DFO RV index. A similar phenomenon exists for the 2004 cohort (detected by sentinel linetrawl but not sentinel gillnet or DFO RV index).

The geographical coverage of tagging since 2007 is very limited; during 2008-2010 cod have only been tagged in Placentia Bay. The lack of recent tagging in other areas adds uncertainty to our understanding of exploitation rates, stock structure, and movement patterns and how these influence survey and commercial catch rates in the recent period.

Trends in the level of natural mortality are difficult to measure and are uncertain.

The relative efficiency of the survey trawl at capturing different age groups is uncertain. Differing patterns of catchability were explored in this assessment and yielded similar outcome in terms of current status relative to the LRP. If the catchabilities differ from the assumed values, stock dynamics may differ from the results presented above.

Survey indices are at times influenced by "year-effects", an atypical survey result that can be caused by a number of factors (e.g., environmental conditions, movement, degree of aggregation, etc.) which may be unrelated to absolute stock size. In the 2009 DFO RV survey the estimated abundance at ages 2-8 increased compared to these cohorts at ages 1-7 as measured in the 2008 survey. This is

unusual and indicates that one (or possibly both) of the 2008 and 2009 surveys may be influenced by a year-effect. Year-effects are also evident in the 1995 and 1997 survey results.

The percentage of the catch from the <35 ft sector that is accounted for in the standardized logbook indices has declined over time and now represents only about 30 % of the catch as compared to approximately 70 % at the start of the time series in 1997. This likely affects the quality, and comparability, of this index over time.

The DFO RV survey covers most of the stock, and survey trends broadly reflect stock trends. Any near-shore aggregations in April would not be measured by the DFO RV survey. The majority of the area shore-ward of the DFO RV survey lies within inner and western Placentia Bay. There is no recent evidence that a large fraction of the stock is shore-ward of the DFO RV survey in April.

Age at 50 % maturity has been declining in recent years. The proportion of female cod maturing at younger ages has been higher for all cohorts subsequent to the 1986 cohort resulting in a significant proportion of SSB made up of younger fish. Questions exist as to whether or not these small, young fish are effective spawners. Given the lack of definitive data regarding size and age effects on spawner quality for this stock, the current practice of equally weighting all components of SSB (regardless of size and age) continues to be employed. However, if young spawners contribute disproportionately less to recruitment than older fish, the current reproductive potential of the stock would be lower than expected and would be reduced in comparison to the pre-1986 SSB, which was comprised of older fish.

ACKNOWLEDGMENTS

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Table 1. Reported landings of cod (t) from NAFO Subdivision 3Ps, 1959 – October 15th, 2010 by country and for fixed and mobile gear sectors.

Year	Can. (Newfoundland) Offshore (Mobile)	Can. (Newfoundland) Inshore (Fixed)	Can. (Mainland) (All gears)	France St. Pierre & Miquelon Inshore	France St. Pierre & Miquelon Offshore	France Metro (All gears)	Spain (All gears)	Portugal (All gears)	Others (All gears)	Total	TAC [3]
1959	2,726	32,718	4,784	3,078		4,952	7,794	3,647	471	60,170	
1960	1,780	40,059	5,095	3,424	210	2,460	17,223	2,658	4,376	77,285	
1961	2,167	32,506	3,883	3,793	347	11,490	21,015	6,070	5,553	86,824	
1962	1,176	29,888	1,474	2,171	70	4,138	10,289	3,542	2,491	55,239	
1963	1,099	30,447	331	1,112	645	324	10,826	209	6,828	51,821	
1964	2,161	23,897	370	1,002	1,095	2,777	15,216	169	9,880	56,567	
1965	2,459	25,902	1,203	1,863	707	1,781	13,404		4,534	51,853	
1966	5,473	23,785	583	-	3,207	4,607	23,678	519	4,355	66,207	
1967	3,861	26,331	1,259	2,244		3,204	20,851	980	4,044	62,774	
1968	6,538	22,938	585	-	880	1,126	26,868	8	18,613	77,556	
1969	4,269	20,009	849	-	2,477	15	28,141	57	7,982	63,799	
1970	4,650	23,410	2,166	1,307	663	35	35,750	143	8,734	76,858	
1971	8,657	26,651	731	1,196	455	2,730	19,169	81	2,778	62,448	
1972	3,323	19,276	252	990	446	-	18,550	109	1,267	44,213	
1973	3,107	21,349	181	976	189	-	19,952	1,180	5,707	52,641	70,500
1974	3,770	15,999	657	600	348	5,366	14,937	1,246	3,789	46,712	70,000
1975	741	14,332	122	586	189	3,549	12,234	1,350	2,270	35,373	62,400
1976	2,013	20,978	317	722	182	1,501	9,236	177	2,007	37,133	47,500
1977	3,333	23,755	2,171	845	407	1,734	-	-	-	32,245	32,500
1978	2,082	19,560	700	360	1,614	2,860	-	-	45	27,221	25,000
1979	2,381	23,413	863	495	3,794	2,060	-	-	-	33,006	25,000
1980	2,809	29,427	715	214	1,722	2,681	-	-	-	37,568	28,000
1981	2,696	26,068	2,321	333	3,768	3,706	-	-	-	38,892	30,000
1982	2,639	21,351	2,948	1,009	3,771	2,184	-	-	-	33,902	33,000
1983	2,100	23,915	2,580	843	4,775	4,238	-	-	-	38,451	33,000
1984	895	22,865	1,969	777	6,773	3,671	-	-	-	36,950	33,000
1985	4,529	24,854	3,476	642	9,422	8,444	-	-	-	51,367	41,000
1986	5,218	24,821	1,963	389	13,653	11,939	-	-	7	57,990	41,000
1987	4,133	26,735	2,517	551	15,303	9,965	-	-	-	59,204	41,000
1988	3,662	19,742	2,308	282	10,011	7,373	-	-	4	43,382	41,000
1989	3,098	23,208	2,361	339	9,642	892	-	-	-	39,540	35,400
1990	3,266	20,128	3,082	158	14,771	-	-	-	-	41,405	35,400
1991	3,916	21,778	2,106	204	15,585	-	-	-	-	43,589	35,400
1992	4,468	19,025	2,238	2	10,162	-	-	-	-	35,895	35,400
1993	1,987	11,878	1,351	-	-	-	-	-	-	15,216	20,000
1994	82	493	86	-	-	-	-	-	-	661	0
1995	26	676	60	59	-	-	-	-	-	821	0
1996	60	836 [2]	118	43		-	-	-	-	1,057	0
1997 [1]	108	7,594 [2]	79	448	1,191	-	-	-	-	9,420	10,000
1998 [1]	2,543	13,609 [2]	885	609	2,511	-	-	-	-	20,156	20,000
1999 [1]	3,059	21,156 [2]	614	621	2,548	-	-	-	-	27,997	30,000
2000 [1]	3,436	16,247 [2]	740	870	3,807	-	-	-	-	25,100	20,000
2001 [1]	2,152	11,187 [2]	856	675	1,675	-	-	-	-	16,546	15,000
2002 [1]	1,326	11,292 [2]	499	579	1,623	-	-	-	-	14,892	15,000
2003 [1]	1,869	10,600 [2]	412	734	1,645	-	-	-	-	15,260	15,000
2004 [1]	1,595	9,450 [2]	790	465	2,113	-	-	-	-	14,414	15,000
2005 [1]	1,863	9,537 [2]	818	617	1,941	-	-	-	-	14,778	15,000
2006 [1]	1,011	9,590 [2]	675	555	1,326	-	-	-	-	13,157	13,000
2007 [1]	1,339	9,303 [4]	294	520	1,503	-	-	-	-	12,959	13,000
2008 [1]	982	8654 [4]	377	467	1293	-	-	-	-	11,773	13,000
2009 [1]	1733	5870 [4]	193	282	1684	-	-	-	-	9,762	11,500
2010 [1]	1133	3804	111	0	515	-	-	-	-	5,563	11,500

[1] Provisional catches

[2] Includes recreational fishery and sentinel fishery.

[3] Since 2000, TAC's have been established for the period 1 April to 31 March rather than by calender year.

[4] Does not include estimates of recreational catch.

Table 2. Reported fixed gear catches of cod (t) from NAFO Subdivision 3Ps by gear type (includes non-Canadian and recreational catch).

Year		Gillnet	Longline	Handline	Trap	Total
1975		4,995	4,083	1,364	3,902	14,344
1976		5,983	5,439	2,346	7,224	20,992
1977		3,612	9,940	3,008	7,205	23,765
1978		2,374	11,893	3,130	2,245	19,642
1979		3,955	14,462	3,123	2,030	23,570
1980		5,493	19,331	2,545	2,077	29,446
1981		4,998	20,540	1,142	948	27,628
1982		6,283	13,574	1,597	1,929	23,383
1983		6,144	12,722	2,540	3,643	25,049
1984		7,275	9,580	2,943	3,271	23,069
1985		7,086	10,596	1,832	5,674	25,188
1986		8,668	11,014	1,634	4,073	25,389
1987		9,304	11,807	1,628	4,931	27,670
1988		6,433	10,175	1,469	2,449	20,526
1989		5,997	10,758	1,657	5,996	24,408
1990		6,948	8,792	2,217	3,788	21,745
1991		6,791	10,304	1,832	4,068	22,995
1992		5,314	10,315	1,330	3,397	20,356
1993		3,975	3,783	1,204	3,557	12,519
1994		90	0	381	0	471
1995		383	182	0	5	570
1996		467	158	137	10	772
1997	[1]	3,760	1,158	1,172	1,167	7,258
1998	[1]	10,116	2,914	308	92	13,430
1999	[1]	17,976	3,714	503	45	22,237
2000	[1]	14,218	3,100	186	56	17,561
2001	[1]	7,377	2,833	2,089	57	12,357
2002	[1]	7,827	2,309	775	119	11,030
2003	[1]	8,313	2,044	546	35	10,937
2004	[1]	7,910	2,167	415	15	10,508
2005	[1]	8,112	2,016	626	6	10,760
2006	[1]	7,590	2,698	314	2	10,603
2007	[1,2]	7,287	2,374	445	11	10,116
2008	[1,2]	6,636	2,482	341	21	9,480
2009	[1,2]	4,052	1,644	612	36	6,344
2010	[1,2,3]	3,067	611	212	4	3,894

[1] provisional catch
[2] excluding recreational catches
[3] catch to October 15th 2010

Table 3. Reported monthly landings (t) of cod from unit areas in NAFO Subdivision 3Ps during 2009 and 2010 (provisional; to October 15th, 2010).

2009	Inshore			Offshore					
Month	3Psa	3Psb	3Psc	3Psd	3Pse	3Psf	3Psg	3Psh	Totals
Jan	2.1	214.9	205.7	0.2	0.7	518.0	0.0	991.1	1,932.7
Feb	16.3	86.8	129.9	0.0	0.0	37.8	2.1	851.6	1,124.4
Mar	0.2	0.0	0.0	5.0	0.0	0.0	4.7	165.7	175.5
Apr	0.0	0.0	0.0	0.1	0.0	0.0	8.1	21.0	29.1
May	26.9	33.3	34.1	1.9	0.8	8.8	0.1	23.4	129.2
Jun	101.3	220.3	435.2	3.0	6.2	14.5	1.5	21.0	803.1
Jul	142.5	274.0	1,077.3	28.8	39.5	37.4	1.2	3.3	1,604.0
Aug	20.3	34.8	49.5	12.1	41.5	50.2	1.0	4.2	213.5
Sep	56.1	38.4	94.9	3.9	239.0	255.1	12.5	18.9	718.8
Oct	97.3	87.1	216.1	62.5	116.1	128.5	29.0	27.7	764.2
Nov	120.4	98.7	450.6	92.3	18.0	645.5	13.2	237.6	1,676.4
Dec	14.1	84.7	127.4	0.0	0.0	116.6	0.0	247.8	590.6
Totals	597.6	1,172.9	2,820.7	209.8	461.8	1,812.4	73.3	2,613.2	9,761.6

* Excludes 0.5 t of catch from unspecified unit area

* Excludes 1036 t of catch by France in 1st quarter 2009 - Month/Unit Area breakdown unavailable.

2010	Inshore			Offshore					
Month	3Psa	3Psb	3Psc	3Psd	3Pse	3Psf	3Psg	3Psh	Totals
Jan	17.3	69.2	166.0	3.4	0.0	149.8	0.7	681.7	1,088.1
Feb	4.4	66.5	129.8	11.6	0.0	115.1	138.9	609.2	1,075.5
Mar	0.2	0.0	0.0	10.3	0.0	1.2	6.9	181.5	199.9
Apr	0.0	0.0	0.0	0.0	0.0	0.0	0.5	8.6	9.1
May	23.1	21.3	16.1	0.0	0.0	0.0	0.0	0.3	60.8
Jun	76.7	159.4	959.6	0.3	0.0	0.0	0.0	6.3	1,202.3
Jul	79.7	191.7	863.8	1.1	5.8	0.0	0.0	4.7	1,146.8
Aug	41.1	69.6	97.3	0.0	0.0	0.0	0.0	2.2	210.3
Sep	21.6	75.4	187.7	0.0	0.0	0.0	0.0	17.1	301.8
Oct	7.3	62.0	199.5	0.0	0.0	0.0	0.0	0.0	268.8
Nov									0.0
Dec									0.0
Totals	271.4	715.3	2,619.7	26.6	5.8	266.0	146.9	1,511.6	5,563.3

28

Table 4. Number of cod sampled for length and age and available to estimate the commercial catch at age for 2009.

	Number Measured (Canada)							
	Offshore			Inshore				
Month	Ottertrawl	Gillnet	Linetrawl	Gillnet	Linetrawl	Handline	Other	Total
Jan	1,826			3,200	1,343		63	6,432
Feb	1,357		409	2,261	635	76		4,738
Mar	1,052				96			1,148
Apr								0
May				542		154		696
Jun				7,419	2,058	314	81	9,872
Jul				4,868	2,324		503	7,695
Aug				542	2,342		111	2,995
Sep		474		199	2,032		49	2,754
Oct		717		466	2,837		0	4,020
Nov		251	561	653	6,456	154	143	8,218
Dec				732	2,327	5	20	3,084
Total	4,235	1,442	970	20,882	22,450	703	970	51,652

	Number Aged (Canada)							
	Offshore			Inshore				
Quarter	Ottertrawl	Gillnet	Linetrawl	Gillnet	Linetrawl	Handline	Ottertrawl	Total
1	612		178	597	197	25		1,609
2				578	251	77		906
3		114		349	696			1,159
4		244	117	207	1,076	33		1,677
Total	612	358	295	1,731	2,220	135	0	5,351

Sampling by France (SPM)

	Measured		Aged	
Quarter	Ottertrawl	Gillnet	Ottertrawl	Gillnet
1				
3				
4	730		32	
Total	730	0	32	0

Table 5. Estimates of average weight (kg), length (cm), and the total numbers (000s) and weight of 3Ps cod caught at age from Canadian and French landings during 2009. Numbers excludes any recreational catches.

| | AVERAGE | | CATCH | | | |
| | WEIGHT | LENGTH | NUMBER | | | Weight (t) |
AGE	(kg.)	(cm.)	(000'S)	STD ERR.	CV	
1			0.00			
2	0.17	26.58	0.11	0.04	0.37	0
3	0.63	41.41	16.93	2.48	0.15	11
4	1.02	48.24	129.15	6.89	0.05	132
5	1.53	54.90	813.50	16.91	0.02	1247
6	1.93	59.20	999.83	35.44	0.04	1931
7	2.38	63.38	902.09	18.59	0.02	2143
8	2.48	63.71	460.21	32.38	0.07	1142
9	2.61	64.88	204.90	9.13	0.04	536
10	3.67	71.47	98.65	5.45	0.06	362
11	5.81	82.50	113.98	5.31	0.05	663
12	7.07	89.00	85.66	3.90	0.05	606
13	7.97	92.73	55.78	3.29	0.06	445
14	9.00	97.36	12.07	1.37	0.11	109
15	10.90	103.70	9.26	1.20	0.13	101
16	13.42	112.05	2.96	0.59	0.20	40
17	15.73	118.53	1.86	0.36	0.19	29
18	15.13	116.32	2.37	0.36	0.15	36
19	16.54	120.26	1.68	0.40	0.24	28
20	20.89	130.15	0.62	0.20	0.31	13

Total (t) 9572
Landings (t) 9762
SOP 0.980

Table 6. Catch numbers-at-age (000s) for the commercial cod fishery in NAFO Subdivision. 3Ps from 1959 to 2009 (only ages 3-14 shown). Recreational catches for 2007 onward are excluded (see text).

Year/Age	3	4	5	6	7	8	9	10	11	12	13	14
1959	1001	13940	7525	7265	4875	942	1252	1260	631	545	44	1
1960	567	5496	23704	6714	3476	3484	1020	827	406	407	283	27
1961	450	5586	10357	15960	3616	4680	1849	1376	446	265	560	58
1962	1245	6749	9003	4533	5715	1367	791	571	187	140	135	241
1963	961	4499	7091	5275	2527	3030	898	292	143	99	107	92
1964	1906	5785	5635	5179	2945	1881	1891	652	339	329	54	27
1965	2314	9636	5799	3609	3254	2055	1218	1033	327	68	122	36
1966	949	13662	13065	4621	5119	1586	1833	1039	517	389	32	22
1967	2871	10913	12900	6392	2349	1364	604	316	380	95	149	3
1968	1143	12602	13135	5853	3572	1308	549	425	222	111	5	107
1969	774	7098	11585	7178	4554	1757	792	717	61	120	67	110
1970	756	8114	12916	9763	6374	2456	730	214	178	77	121	14
1971	2884	6444	8574	7266	8218	3131	1275	541	85	125	62	57
1972	731	4944	4591	3552	4603	2636	833	463	205	117	48	45
1973	945	4707	11386	4010	4022	2201	2019	515	172	110	14	29
1974	1887	6042	9987	6365	2540	1857	1149	538	249	80	32	17
1975	1840	7329	5397	4541	5867	723	1196	105	174	52	6	2
1976	4110	12139	7923	2875	1305	495	140	53	17	21	4	3
1977	935	9156	8326	3209	920	395	265	117	57	43	31	11
1978	502	5146	6096	4006	1753	653	235	178	72	27	17	10
1979	135	3072	10321	5066	2353	721	233	84	53	24	13	10
1980	368	1625	5054	8156	3379	1254	327	114	56	45	21	25
1981	1022	2888	3136	4652	5855	1622	539	175	67	35	18	2
1982	130	5092	4430	2348	2861	2939	640	243	83	30	11	7
1983	760	2682	9174	4080	1752	1150	1041	244	91	37	18	8
1984	203	4521	4538	7018	2221	584	542	338	134	35	8	8
1985	152	2639	8031	5144	5242	1480	626	545	353	109	21	6
1986	306	5103	10253	11228	4283	2167	650	224	171	143	79	23
1987	585	2956	11023	9763	5453	1416	1107	341	149	78	135	50
1988	935	4951	4971	6471	5046	1793	630	284	123	75	53	31
1989	1071	8995	7842	2863	2549	1112	600	223	141	57	29	26
1990	2006	8622	8195	3329	1483	1237	692	350	142	104	47	22
1991	812	7981	10028	5907	2164	807	620	428	108	76	50	22
1992	1422	4159	8424	6538	2266	658	269	192	187	83	34	41
1993	278	3712	2035	3156	1334	401	89	38	52	13	14	5
1994	9	78	173	74	62	28	12	3	2	0	0	0
1995	3	7	56	119	57	37	7	2	0	0	0	0
1996	9	43	43	101	125	35	24	8	2	1	0	0
1997	66	427	1130	497	937	826	187	93	31	4	1	0
1998	91	373	793	1550	948	1314	1217	225	120	56	15	1
1999	49	628	1202	2156	2321	1020	960	873	189	110	21	8
2000	76	335	736	1352	1692	1484	610	530	624	92	37	16
2001	80	475	718	1099	1143	796	674	257	202	192	28	13
2002	155	607	1451	1280	900	722	419	355	96	70	71	14
2003	15	301	879	1810	1139	596	337	277	167	67	55	84
2004	62	113	654	1592	1713	649	266	180	104	47	17	24
2005	49	330	515	1007	1628	1087	499	143	95	41	26	12
2006	43	253	866	928	846	1055	632	237	80	36	19	7
2007	97	311	727	1072	761	501	526	401	160	44	34	21
2008	35	422	617	1105	976	634	350	295	193	91	27	12
2009	17	129	813	1000	902	460	205	99	114	86	56	12

Table 7a. Mean annual weights-at-age (kg) calculated from lengths-at-age based on samples from commercial fisheries (including food fisheries and sentinel surveys where available) in Subdivision 3Ps in 1959-2009. The weights-at-age from 1976 are extrapolated back to 1959.

Year/Age	3	4	5	6	7	8	9	10	11	12	13	14
1959	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1960	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1961	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1962	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1963	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1964	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1965	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1966	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1967	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1968	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1969	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1970	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1971	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1972	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1973	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1974	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1975	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1976	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1977	0.49	0.44	0.95	1.42	2.12	2.86	3.67	4.50	5.48	6.38	7.84	9.37
1978	0.37	0.62	0.86	1.51	2.13	2.83	3.74	4.65	5.05	6.53	7.24	8.75
1979	0.31	0.54	0.84	1.33	2.11	3.00	3.59	5.16	6.01	6.51	8.28	9.17
1980	0.42	0.54	0.86	1.29	2.02	3.03	4.46	5.47	6.88	7.78	8.75	9.55
1981	0.38	0.64	0.97	1.43	1.95	2.85	3.96	5.54	7.18	8.12	8.51	9.44
1982	0.33	0.61	0.96	1.53	2.06	2.57	3.58	4.80	5.92	7.99	8.84	9.78
1983	0.43	0.61	1.01	1.53	2.14	2.77	3.30	4.44	5.89	7.23	9.31	10.11
1984	0.58	0.78	1.08	1.62	2.29	3.12	3.94	4.58	5.50	7.70	9.73	10.23
1985	0.58	0.75	1.13	1.58	2.35	3.01	4.35	5.34	5.83	6.57	9.42	10.83
1986	0.45	0.69	1.00	1.50	2.09	2.98	3.85	5.25	6.10	7.30	7.60	10.81
1987	0.46	0.64	0.95	1.39	2.06	2.71	3.69	4.69	5.84	6.57	7.86	8.19
1988	0.56	0.68	0.92	1.42	1.88	2.60	3.29	4.64	5.35	6.40	7.22	7.95
1989	0.54	0.71	0.98	1.33	1.94	2.70	3.46	4.31	5.60	6.40	7.15	8.07
1990	0.51	0.74	1.01	1.46	2.00	2.60	3.77	4.57	5.74	6.91	7.79	8.96
1991	0.56	0.66	1.00	1.49	2.09	2.67	3.33	4.22	5.68	6.98	8.10	8.99
1992	0.38	0.65	0.88	1.35	1.97	2.62	3.47	4.52	5.21	7.04	8.94	10.13
1993	0.23	0.56	0.86	1.24	1.82	2.51	3.54	4.22	5.09	6.94	7.32	9.25
1994	0.53	0.54	0.94	1.42	1.74	2.42	3.19	4.36	5.20	6.03	7.13	7.43
1995	0.38	0.72	1.13	1.63	2.14	2.39	3.08	3.93	4.32	5.12	6.59	7.92
1996	0.58	0.72	1.12	1.79	2.26	2.70	3.00	3.73	4.55	4.47	5.49	7.45
1997	0.48	0.78	1.13	1.67	2.27	2.86	3.20	3.37	4.30	5.54	6.34	8.83
1998	0.51	0.79	1.19	1.63	2.13	2.79	3.62	3.79	4.03	4.89	6.38	9.12
1999	0.62	0.76	1.27	1.90	2.28	2.61	3.49	4.64	4.54	4.93	5.66	6.82
2000	0.48	0.79	1.12	1.80	2.52	2.67	2.98	4.25	5.90	5.53	5.82	6.89
2001	0.57	0.79	1.14	1.62	2.31	3.06	3.00	3.30	5.07	7.50	6.83	7.22
2002	0.44	0.84	1.25	1.71	2.12	2.83	3.84	3.53	3.66	5.82	8.75	7.77
2003	0.57	0.75	1.27	1.81	2.19	2.47	3.46	4.53	4.09	4.54	6.88	9.59
2004	0.46	0.81	1.15	1.79	2.29	2.53	2.74	4.41	5.64	4.75	6.16	8.29
2005	0.51	0.74	1.16	1.59	2.24	2.69	2.94	3.04	4.68	6.42	5.38	7.48
2006	0.44	0.80	1.21	1.64	2.00	2.60	3.16	3.31	3.19	4.63	6.37	6.44
2007	0.56	0.94	1.44	1.96	2.24	2.53	3.73	4.96	5.51	4.86	7.08	8.81
2008	0.63	0.89	1.30	1.91	2.20	2.43	2.59	3.47	4.82	4.98	4.55	7.77
2009	0.62	1.02	1.54	1.93	2.37	2.47	2.61	3.64	5.77	7.04	7.96	8.94

Table 7b. Beginning of the year weights-at-age calculated from commercial annual mean weights-at-age. The values for 1976 are extrapolated back to 1959.

Year/Age	3	4	5	6	7	8	9	10	11	12	13	14
1959	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1960	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1961	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1962	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1963	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1964	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1965	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1966	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1967	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1968	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1969	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1970	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1971	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1972	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1973	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1974	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1975	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1976	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1977	0.49	0.44	0.95	1.42	2.12	2.86	3.67	4.50	5.48	6.38	7.84	9.37
1978	0.37	0.62	0.86	1.51	2.13	2.83	3.74	4.65	5.05	6.53	7.24	8.75
1979	0.31	0.54	0.84	1.33	2.11	3.00	3.59	5.16	6.01	6.51	8.28	9.17
1980	0.42	0.54	0.86	1.29	2.02	3.03	4.46	5.47	6.88	7.78	8.75	9.55
1981	0.38	0.64	0.97	1.43	1.95	2.85	3.96	5.54	7.18	8.12	8.51	9.44
1982	0.33	0.61	0.96	1.53	2.06	2.57	3.58	4.80	5.92	7.99	8.84	9.78
1983	0.43	0.61	1.01	1.53	2.14	2.77	3.30	4.44	5.89	7.23	9.31	10.11
1984	0.58	0.78	1.08	1.62	2.29	3.12	3.94	4.58	5.50	7.70	9.73	10.23
1985	0.58	0.75	1.13	1.58	2.35	3.01	4.35	5.34	5.83	6.57	9.42	10.83
1986	0.45	0.69	1.00	1.50	2.09	2.98	3.85	5.25	6.10	7.30	7.60	10.81
1987	0.46	0.64	0.95	1.39	2.06	2.71	3.69	4.69	5.84	6.57	7.86	8.19
1988	0.56	0.68	0.92	1.42	1.88	2.60	3.29	4.64	5.35	6.40	7.22	7.95
1989	0.54	0.71	0.98	1.33	1.94	2.70	3.46	4.31	5.60	6.40	7.15	8.07
1990	0.51	0.74	1.01	1.46	2.00	2.60	3.77	4.57	5.74	6.91	7.79	8.96
1991	0.56	0.66	1.00	1.49	2.09	2.67	3.33	4.22	5.68	6.98	8.10	8.99
1992	0.38	0.65	0.88	1.35	1.97	2.62	3.47	4.52	5.21	7.04	8.94	10.13
1993	0.23	0.56	0.86	1.24	1.82	2.51	3.54	4.22	5.09	6.94	7.32	9.25
1994	0.53	0.54	0.94	1.42	1.74	2.42	3.19	4.36	5.20	6.03	7.13	7.43
1995	0.38	0.72	1.13	1.63	2.14	2.39	3.08	3.93	4.32	5.12	6.59	7.92
1996	0.58	0.72	1.12	1.79	2.26	2.70	3.00	3.73	4.55	4.47	5.49	7.45
1997	0.48	0.78	1.13	1.67	2.27	2.86	3.20	3.37	4.30	5.54	6.34	8.83
1998	0.51	0.79	1.19	1.63	2.13	2.79	3.62	3.79	4.03	4.89	6.38	9.12
1999	0.62	0.76	1.27	1.90	2.28	2.61	3.49	4.64	4.54	4.93	5.66	6.82
2000	0.48	0.79	1.12	1.80	2.52	2.67	2.98	4.25	5.90	5.53	5.82	6.89
2001	0.57	0.79	1.14	1.62	2.31	3.06	3.00	3.30	5.07	7.50	6.83	7.22
2002	0.44	0.84	1.25	1.71	2.12	2.83	3.84	3.53	3.66	5.82	8.75	7.77
2003	0.57	0.75	1.27	1.81	2.19	2.47	3.46	4.53	4.09	4.54	6.88	9.59
2004	0.46	0.81	1.15	1.79	2.29	2.53	2.74	4.41	5.64	4.75	6.16	8.29
2005	0.51	0.74	1.16	1.59	2.24	2.69	2.94	3.04	4.68	6.42	5.38	7.48
2006	0.46	0.80	1.21	1.64	2.00	2.60	3.16	3.31	3.19	4.63	6.37	6.44
2007	0.47	0.73	1.21	1.74	2.08	2.34	3.20	4.13	4.37	3.90	5.90	7.62
2008	0.49	0.70	1.10	1.66	2.08	2.33	2.56	3.60	4.89	5.24	4.70	7.42
2009	0.46	0.80	1.17	1.58	2.13	2.34	2.52	3.07	4.47	5.83	6.29	6.38

Table 8. Standardized gillnet (5.5 in mesh) and line-trawl annual catch rate-at-age indices estimated using data from sentinel fishery fixed sites. Catch rates are expressed as fish per net for gill nets and fish per 1000 hooks for line-trawl. The 1997 and 1998 cohorts are shaded.

Gillnet (5.5")

Year/Age	3	4	5	6	7	8	9	10	Total
1995	0.02	0.08	4.06	8.80	5.35	2.49	0.39	0.15	21.34
1996	0.02	0.27	2.69	12.33	10.05	2.87	0.86	0.07	29.15
1997	0.01	0.24	5.27	5.25	9.35	7.56	1.11	0.61	29.40
1998	0.00	0.06	1.13	7.80	3.51	2.75	1.70	0.32	17.26
1999	0.05	0.07	0.52	0.90	1.44	0.65	0.29	0.28	4.20
2000	0.01	0.02	0.30	0.71	0.71	0.97	0.32	0.11	3.15
2001	0.03	0.16	0.41	0.88	0.68	0.38	0.37	0.18	3.08
2002	0.00	0.04	0.49	0.80	0.77	0.33	0.15	0.17	2.75
2003	0.01	0.05	0.22	0.98	0.47	0.18	0.09	0.04	2.05
2004	0.00	0.05	0.22	0.82	0.83	0.40	0.14	0.03	2.48
2005	0.00	0.02	0.13	0.58	0.67	0.38	0.29	0.05	2.14
2006	0.00	0.05	0.30	0.57	0.52	0.58	0.24	0.14	2.41
2007	0.00	0.05	0.41	1.05	0.74	0.38	0.28	0.18	3.09
2008	0.00	0.08	0.28	1.07	0.90	0.44	0.22	0.10	3.10
2009	0.02	0.03	0.26	0.65	1.15	0.23	0.18	0.05	2.56

Linetrawl

Year/Age	3	4	5	6	7	8	9	10	Total
1995	7.7	14.7	51.3	73.9	19.6	18.3	4.3	1.5	191.3
1996	8.0	29.1	28.1	45.2	46.6	13.4	7.5	1.8	179.7
1997	5.7	22.8	24.4	16.0	16.8	23.0	2.8	1.7	113.2
1998	7.2	16.5	21.6	16.1	6.2	9.7	11.5	2.4	91.2
1999	5.8	17.3	23.8	13.7	7.8	4.9	4.7	2.0	80.0
2000	12.5	27.7	25.8	17.2	8.1	6.4	2.4	1.0	101.1
2001	17.7	30.7	22.7	13.5	7.4	4.2	2.3	0.7	99.2
2002	13.6	28.1	25.5	8.9	5.5	1.9	1.0	0.8	85.3
2003	2.6	34.3	39.2	20.1	8.3	3.5	1.3	0.9	110.2
2004	9.1	9.8	36.0	19.0	10.2	3.3	1.6	0.4	89.4
2005	7.1	20.0	13.0	13.1	11.4	4.4	2.0	0.9	71.9
2006	8.7	17.0	26.4	20.0	13.3	12.0	3.6	1.6	102.6
2007	10.8	19.1	16.7	14.0	8.5	5.1	4.6	1.8	80.6
2008	5.2	25.6	22.6	18.7	9.0	5.8	2.8	2.6	92.3
2009	5.2	13.6	27.8	15.8	6.4	3.8	1.7	1.3	75.6

Table 9. Cod abundance estimates (000's of fish) from DFO bottom-trawl research vessel surveys in NAFO Division 3Ps during 1997-2010. Shaded cells are model estimates. See Fig. 13 for location of strata. For 1983-1996 results see Brattey et al. (2007).

Depth range (fathoms)	Strata	sq. mi.	WT 202-203 158 12-Apr 1997	WT 219-220 176 21-Apr 1998	WT 236-237 175 24-Apr 1999	WT 313-315 171 21-Apr 2000	Tel 351 WT 364-365 173 18-Apr 2001	WT 418-419 177 15-Apr 2002	WT 476-477 176 22-Apr 2003	Tel 522 WT 523+546 177 24-Apr 2004	AN 656 WT 617-618 178 27-Apr 2005	WT 688 24 2006	WT 757-759 178 18-Apr 2007	WT 824-827 169 2-May 2008	AN 902-904 175 24-Apr 2009	AN 930-932 177 21-Apr 2010
<30	314	974	77	57	1729	1531	153	67	19	117	256		1570	2144	573	287
	320	1320	303	1292	3546	5183	1543	478	1601	396	523		333	363	3222	1260
31-50	293 [5]	159	107	292	601	394	219	131	120	375	2850	200	317	252	208	55
	308	112	262	4175	2704	1829	1094	285	77	2265	16719		1410	2373	486	16893
	312	272	19	100	461	1235	636	112	150	56	1141		370	270	0	112
	315	827	38	5721	2428	1895	1040	228	49	395	1161		1268	675	1634	767
	321	1189	18	49	894	1161	55	98	82	16	229		65	189	218	1823
	325	944	108	16	752	2824	1526	65	16	1120	383		893	812	1542	7970
	326	166	0	11	52	109	57	0	0	0	0		285	11	0	11
	783 [1]	229	47	16	110	86	142	13	95	16	252	nf	126	126	157	515
51-100	294 [5]	135	176	901	362	170	195	613	455	288	20685	1092	1281	108	4960	713
	297 [5]	152	408	209	1892	7000	450	450	42	244	1317	20732	1047	273	1056	4242
	307	395	1123	23490	5879	6991	5665	833	22912	9328	3172		2735	4849	18237	7758
	311	317	371	1652	2169	2864	610	780	349	2733	788		1715	2519	3632	9627
	317	193	451	173	305	1487	637	1049	372	199	1367		2522	2881	912	3215
	319	984	1889	15600	11839	9327	58696	34398	2149	26117	6064		15245	14670	24418	20120
	322	1567	234	260	713	1529	413	633	263	649	2463		2507	1297	1049	820
	323	696	24	32	158	1001	941	64	19	0	101		32	3300	105	15274
	324	494	272	160	361	442	85	306	391	85	432		481	153	359	417
	781 [1]	446	195	276	1058	716	1564	261	215	1052	568	491	445	552	548	293
	782 [1]	183	63	38	38	315	76	227	50	63	221	nf	101	227	201	22
101-150	295 [5]	209	168	465	976	615	978	144	187	72	976	1781	1469	633	396	2441
	298 [5]	171	110	1861	46	3450	670	371	5399	976	282	21	7475	3384	73	585
	300 [5]	217	584	1579	641	896	791	746	1370	168	657	327	478	90	507	194
	306	363	816	771	708	4191	949	246	277	666	1015		2175	818	4054	714
	309	296	260	11980	215	142	2056	13172	484	109	582		1122	244	49	236
	310	170	1380	105	131	187	505	485	1391	12	249		94	269	30	143
	313	165	0	454	91	113	3564	125	567	10	66		124	23	111	259
	316	189	65	104	23	13	26	117	273	69	117		117	13	116	10
	318	129	1881	53	0	231	44	71	11943	275	683		336	16	189	18
	779 [1]	422	0	39	0	73	26	29	15	19	142	77	671	310	186	0
	780 [1]	403	35	18	0	40	0	0	0	0	18	nf	400	0	37	0
151-200	296 [5]	71	632	4	375	107	1924	735	303	2627	35	54	881	273	999	32
	299 [5]	212	643	49	0	13	131	160	214	44	29	44	44	13	13	42
	705	195	241	376	24	54	83	241	232	267	64		0	76	155	36
	706	476	172	327	87	49	49	82	246	120	310		31	65	87	258
	707	74	353	102	9	0	293	3079	143	121	1263		122	257	737	23
	715	128	516	5874	484	751	3013	1615	960	102	305		132	170	599	63
	716	539	91	3089	2428	196	99	1333	952	74	142		1368	51	1546	180
201-300	708	126	388	1464	947	0	35	151	329	85	1419		641	0	4299	26
	711	593	44	16	0	783	80	49	96	29	1530		505	29	125	44
	712	731	60	201	50	98	117	87	345	60	15		106	54	60	15
	713	851	902	61	78	176	364	320	372	127	80		45	17	99	56
	714	1074	2765	485	173	151	3781	1346	1678	230	77		373	44	819	55
301-400	709 [2]	147	nf	0	0	10	30	0	611	0	0		0	13	0	0
401-500	710 [1]	156	nf	nf	0	nf	nf	nf	nf	nf	nf		nf	nf	nf	nf
501-600	776 [1]	159	nf	nf	nf	nf	nf	nf	nf	nf	nf		nf	nf	nf	nf
601-700	777 [1]	183	nf	nf	nf	nf	nf	nf	nf	nf	nf		nf	nf	nf	nf
701-800	778 [1]	166	nf	nf	nf	nf	nf	nf	nf	nf	nf		nf	nf	nf	nf
	Total [3]		15,123	78,250	39,438	46,543	88,209	61,895	48,737	45,832	42,716		38,722	38,652	69,462	88,490
	Total [4]		18,291	83,997	45,537	60,428	95,405	65,775	57,813	51,776	70,748		53,457	44,906	78,803	97,625
	upper		21,365	166,891	55,196	60,749	147,318	119,231	109,897	95,755	171,310		48,978	55,629	103,588	139,453
	t-value		2.31	3.18	2.23	2.20	2.36	2.78	3.18	2.31	4.30		4.30	2.20	2.23	2.11
	std [6]		2,702	27,857	7,066	6,457	25,046	20,624	19,233	21,649	29,906		2,383	7,713	15,303	24,153

[1] These strata were added to the stratification scheme in 1994.

[2] Stratum 709 was redrawn in 1994 and includes stratum 710 from previous surveys. All sets in 710 prior to 1994 were recoded to 709.

[3] For index strata 0-300 fathoms in the offshore and includes estimates (shaded cells) for non-sampled strata .

[4] totals are for all strata fished .

[5] These strata were added to the stratification scheme in 1997.

[6] std's are for index strata and do not include estimates from non-sampled strata.

Table 10. Cod biomass estimates (t) from DFO research vessel bottom-trawl surveys in NAFO Subdivision 3Ps during 1997-2009. Shaded cells are model estimates. See Fig. 13 for location of strata. For 1983-1996 results see Brattey et al. (2007).

Depth range (fathoms)	Strata		WT 202-203	WT 219-220	WT 236-237	WT 313-315	Tel 351 WT 364-365	WT 418-419	WT 476-477	Tel 522 WT 523+546	AN 656 WT 617-618	WT 688	WT 757-759	WT 824-827	AN 902-904	AN 930-932
		Vessel Trips	158	176	175	171	173	177	176	177	178	24	178	169	175	177
		Sets														
		Mean Date	12-Apr	21-Apr	24-Apr	21-Apr	18-Apr	15-Apr	22-Apr	24-Apr	27-Apr	15-Apr	18-Apr	2-May	24-Apr	21-Apr
		sq. mi.	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
<30	314	974	32	8	595	829	46	5	0	10	185	nf	53	204	68	43
	320	1320	114	7766	6287	6761	601	932	2707	395	1890	nf	1274	442	1069	603
31-50	293[5]	159	17	19	27	45	26	9	29	18	1810	34	16	18	7	15
	308	112	93	1461	1572	1088	184	48	12	1949	8011	nf	253	789	170	8343
	312	272	13	8	226	640	93	10	9	18	345	nf	60	434	0	37
	315	827	14	20072	3771	3092	491	822	17	335	13514	nf	6456	99	1777	235
	321	1189	2	0	1855	4582	2	5	2	2	40	nf	186	17	54	2054
	325	944	10	0	418	1307	340	10	3	568	84	nf	172	555	447	4194
	326	166	0	0	8	478	25	0	0	0	0	nf	55	1	0	19
	783[1]	229	0	0	14	16	6	0	2	1	303	nf	12	18	13	31
51-100	294[5]	135	24	40	19	7	26	47	22	14	21147	716	85	27	149	55
	297[5]	152	39	22	1697	2339	108	38	5	42	1482	20678	382	122	156	1224
	307	395	332	16164	3784	5162	1578	197	26828	6055	2423	nf	1471	3059	8114	4100
	311	317	51	169	3342	1661	26	145	13	182	570	nf	83	219	395	2414
	317	193	62	196	36	259	331	88	59	78	218	nf	1118	231	158	2436
	319	984	287	28144	18019	8121	51570	38958	755	67844	5845	nf	14166	8888	33064	20494
	322	1567	118	13	117	1893	193	32	26	38	1532	nf	79	205	104	439
	323	696	15	112	227	643	305	7	1	0	28	nf	1	2525	4	10070
	324	494	11	8	252	25	7	14	13	8	148	nf	51	39	53	39
	781[1]	446	22	16	64	49	36	13	17	61	203	62	23	49	28	33
	782[1]	183	2	7	1	7	0	27	1	3	34	nf	5	13	20	1
101-150	295[5]	209	24	139	45	61	124	8	26	4	727	253	128	83	20	519
	298[5]	171	42	2608	148	2632	202	75	2735	488	250	30	8445	2881	56	250
	300[5]	217	147	802	650	307	153	124	175	103	391	192	149	25	286	111
	306	363	312	618	553	5123	543	67	51	960	812	nf	2142	645	2021	630
	309	296	87	9788	320	303	1118	15666	193	56	464	nf	1328	673	10	282
	310	170	206	72	145	330	488	209	263	4	410	nf	11	427	7	82
	313	165	0	481	162	97	18231	122	807	4	101	nf	352	79	61	213
	316	189	40	138	43	21	63	78	146	103	95	nf	120	5	156	7
	318	129	404	88	0	592	28	43	12705	506	1672	nf	445	25	189	32
	779[1]	422	0	10	0	4	1	1	2	1	47	5	41	38	18	0
	780[1]	403	3	1	0	6	0	0	0	0	2	nf	86	0	2	0
151-200	296[5]	71	175	1	102	20	341	118	36	900	54	20	146	76	239	5
	299[5]	212	282	231	0	1	411	655	315	35	15	30	327	1	2	26
	705	195	476	345	25	20	71	244	434	288	96	nf	0	111	122	47
	706	476	379	266	68	63	26	40	431	147	301	nf	56	76	51	153
	707	74	72	121	21	0	360	3726	187	329	3347	nf	109	243	469	20
	715	128	233	6849	1127	1240	5599	2525	1188	114	451	nf	167	296	1793	101
	716	539	44	1772	4106	229	92	554	735	75	123	nf	1933	59	961	124
201-300	708	126	629	4389	1455	0	54	139	354	76	1272	nf	940	0	3688	16
	711	593	43	11	0	1242	75	35	41	22	1864	nf	1024	52	100	33
	712	731	151	267	25	64	65	25	264	39	6	nf	94	81	52	10
	713	851	1101	48	143	123	273	235	261	172	63	nf	27	5	59	101
	714	1074	3471	725	155	123	4113	1212	2306	183	149	nf	514	51	808	55
301-400	709[2]	147	nf	0	0	5	59	0	383	0	0	nf	0	24	0	0
401-500	710[1]	156	nf	nf	0	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
501-600	776[1]	159	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
601-700	777[1]	183	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
701-800	778[1]	166	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
	Total[3]		8,802	100,100	48,857	46,111	86,991	66,193	50,811	80,560	46,059		34,740	20,535	56,024	57,429
	Total[4]		9,579	103,996	51,624	51,610	88,484	67,308	54,559	82,230	72,524		44,585	23,910	57,020	59,698
	upper		14,193	160,874	71,356	60,876	148,519	134,681	127,771	218,043	146,619		53,944	31,842	107,025	99,022
	t-value		2.36	2.201	2.13	2.15	2.57	2.78	3.18	2.365	3.18		2.12	2.31	2.31	2.2
	std[6]		2,284	27,612	10,563	6,867	23,941	24,636	24,201	58,132	31,623		9,058	4,895	22,078	18,906

[1] These strata were added to the stratification scheme in 1994.
[2] Strata 709 was redrawn in 1994 and includes the area covered by strata 710 previously. All sets done in 710 prior to 1994 recoded to 709.
[3] For index strata 0-300 fathoms in the offshore and includes esitmates (shaded cells) for non-sampled strata.
[4] totals are for all strata fished.
[5] These strata were added to the stratification scheme in 1997.
[6] std's are for index strata and do not include estimates from non-sampled strata.

Table 11a. Mean numbers per tow at age (1-15 only) in Campelen units for the Canadian research vessel bottom trawl survey of NAFO Subdivision 3Ps. Data are adjusted for missing strata. Upper table includes all data from offshore index strata; lower table includes data from inshore and offshore strata (area covered since 1997 – refer to text for additional detail). The survey in 2006 was not completed and there were two surveys in 1993 (February and April).

Offshore Only (1983-2010)

Year/Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
1983	6.42	10.01	6.52	1.14	3.72	1.62	0.48	0.89	1.61	0.75	0.36	0.14	0.06	0.05	0.04	33.81
1984	0.30	5.40	2.33	1.55	0.63	2.11	0.77	0.37	0.46	0.71	0.18	0.15	0.06	0.03	0.00	15.03
1985	0.38	7.74	14.88	12.57	9.96	3.28	2.66	0.79	0.48	0.42	0.42	0.49	0.21	0.12	0.03	54.43
1986	0.20	6.62	5.65	6.48	7.95	6.33	2.13	1.47	0.84	0.29	0.24	0.29	0.17	0.10	0.06	38.82
1987	1.09	8.48	5.67	4.97	13.82	8.31	3.35	1.29	0.69	0.28	0.23	0.16	0.17	0.16	0.06	48.73
1988	0.42	9.13	5.93	2.96	2.84	6.50	5.84	3.65	1.49	0.84	0.74	0.35	0.16	0.15	0.09	41.09
1989	0.49	6.50	4.66	3.17	1.51	1.16	2.15	1.21	0.67	0.37	0.41	0.13	0.11	0.05	0.09	22.68
1990	0.00	1.48	9.82	14.49	10.89	5.67	3.84	3.14	1.15	0.71	0.32	0.16	0.12	0.09	0.01	51.88
1991	1.30	27.69	5.03	10.00	11.24	5.75	2.84	1.58	1.19	0.74	0.56	0.22	0.11	0.07	0.04	68.36
1992	0.00	1.80	6.95	2.11	4.15	2.03	1.03	0.53	0.26	0.24	0.08	0.04	0.01	0.01	0.02	19.26
1993 (Feb)	0.00	0.00	1.83	4.03	0.71	2.96	0.68	0.33	0.13	0.09	0.11	0.03	0.04	0.01	0.01	10.96
1993 (Apr)	0.00	0.00	1.99	4.04	1.49	1.35	0.47	0.10	0.04	0.03	0.04	0.01	0.00	0.01	0.01	9.58
1994	0.00	1.63	1.46	4.31	6.10	1.73	1.62	0.50	0.08	0.04	0.03	0.02	0.01	0.01	0.00	17.54
1995	0.00	0.31	1.16	1.67	13.08	19.65	4.40	5.75	2.19	0.25	0.20	0.01	0.07	0.03	0.00	48.77
1996	0.90	1.08	3.67	3.62	1.32	2.69	2.91	0.54	0.46	0.09	0.09	0.02	0.00	0.00	0.00	17.39
1997	0.22	1.53	2.33	1.04	0.50	0.28	0.30	0.24	0.14	0.05	0.02	0.00	0.00	0.00	0.00	6.65
1998	0.52	0.97	6.79	8.42	5.60	3.99	1.96	2.50	2.79	0.43	0.30	0.06	0.03	0.00	0.00	34.36
1999	1.24	2.54	2.55	2.38	2.58	2.34	1.72	0.44	0.79	0.60	0.09	0.02	0.02	0.00	0.00	17.31
2000	1.25	3.33	5.36	3.10	2.17	1.82	1.20	0.89	0.35	0.31	0.53	0.12	0.00	0.01	0.00	20.44
2001	0.57	2.26	12.41	12.29	4.36	2.04	1.26	0.77	0.71	0.38	0.50	0.94	0.12	0.06	0.03	38.70
2002	0.58	1.10	3.90	8.28	5.85	3.04	2.04	0.99	0.53	0.37	0.08	0.12	0.19	0.01	0.00	27.08
2003	0.52	1.46	1.78	4.08	6.55	3.94	1.50	0.72	0.33	0.18	0.19	0.05	0.11	0.01	0.01	21.43
2004	0.20	1.90	2.07	1.71	2.08	4.05	4.24	1.26	0.81	0.67	0.79	0.15	0.10	0.02	0.07	20.12
2005	0.77	1.43	6.73	4.96	1.60	0.89	0.79	0.71	0.28	0.05	0.17	0.08	0.03	0.03	0.09	18.61
2006																
2007	3.18	1.73	4.84	3.11	1.48	0.76	0.44	0.22	0.47	0.42	0.12	0.09	0.08	0.05	0.01	17.00
2008	0.47	4.39	4.51	3.32	1.92	1.12	0.47	0.32	0.12	0.15	0.10	0.04	0.03	0.01	0.00	16.97
2009	0.40	1.43	9.25	6.67	5.70	3.09	1.79	0.99	0.21	0.17	0.21	0.38	0.14	0.02	0.00	30.45
2010	0.60	2.13	7.65	15.71	6.70	4.06	1.47	0.29	0.10	0.04	0.04	0.09	0.01	0.00	0.00	38.89

Combined Inshore+Offshore (1997-2010)

Year/Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
1997	0.32	1.68	2.44	1.01	0.46	0.25	0.26	0.21	0.12	0.04	0.01	0.00	0.00	0.00	0.00	6.80
1998	0.72	1.28	6.28	7.40	4.91	3.53	1.73	2.19	2.43	0.38	0.26	0.06	0.03	0.00	0.00	31.20
1999	1.31	3.05	2.52	2.26	2.41	2.12	1.54	0.39	0.68	0.52	0.07	0.02	0.02	0.01	0.00	16.92
2000	1.38	3.84	6.66	3.52	2.24	1.75	1.11	0.80	0.31	0.28	0.46	0.11	0.00	0.01	0.00	22.47
2001	0.99	2.88	11.44	10.58	3.71	1.74	1.08	0.66	0.60	0.32	0.43	0.80	0.10	0.05	0.03	35.41
2002	0.79	1.53	3.72	7.08	4.95	2.58	1.73	0.85	0.45	0.31	0.07	0.11	0.16	0.01	0.00	24.34
2003	0.61	2.62	2.24	3.67	5.88	3.51	1.34	0.63	0.28	0.16	0.17	0.04	0.09	0.01	0.01	21.26
2004	0.33	2.24	2.5	1.85	1.93	3.49	3.61	1.08	0.68	0.57	0.67	0.13	0.09	0.02	0.06	19.25
2005	0.8	1.63	7.32	7.27	3.49	2.08	1.52	1.2	0.41	0.09	0.15	0.06	0.03	0.03	0.08	26.16
2006																
2007	3.31	2.34	5.33	3.26	2.11	1.14	0.76	0.35	0.56	0.37	0.12	0.1	0.07	0.04	0.01	19.87
2008	0.55	4.09	4.3	3.27	1.99	1.22	0.5	0.34	0.12	0.14	0.08	0.04	0.02	0.01	0	16.67
2009	1.44	2.47	8.64	5.81	4.91	2.65	1.53	0.84	0.18	0.15	0.18	0.32	0.12	0.01	0	29.25
2010	0.68	2.76	7.75	13.95	5.87	3.53	1.27	0.25	0.08	0.03	0.03	0.07	0.01	0	0	36.28

Table 11b. Mean numbers per tow at age in Campelen units for the Canadian research vessel bottom trawl survey of the eastern and western (Burgeo area) portions of NAFO Subdivision 3Ps. Data are adjusted for missing strata. There were two surveys in 1993 (February and April) and the 2006 survey was not completed. Only ages 1-14 and data for 1993 onwards are shown.

Eastern 3Ps (1993-2010)

Year/Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
1993 (Apr)	0.00	0.00	1.73	2.60	0.60	0.49	0.28	0.05	0.01	0.00	0.01	0.00	0.00	0.00	0.01	5.78
1994	0.00	1.81	0.73	2.92	3.72	0.65	0.73	0.17	0.01	0.03	0.01	0.01	0.01	0.01	0.00	10.81
1995	0.00	0.24	0.92	1.19	15.65	22.81	2.93	3.60	2.27	0.29	0.23	0.00	0.07	0.02	0.01	50.23
1996	0.98	0.98	1.96	1.89	0.62	1.79	2.38	0.35	0.16	0.10	0.07	0.02	0.00	0.00	0.00	11.30
1997	0.35	2.32	1.70	0.48	0.17	0.09	0.14	0.11	0.04	0.02	0.01	0.00	0.00	0.00	0.00	5.43
1998	0.60	0.82	1.84	2.04	1.68	1.08	0.64	2.50	2.91	0.27	0.07	0.04	0.00	0.00	0.00	14.49
1999	1.67	2.68	1.94	1.00	1.81	2.00	1.34	0.35	0.83	0.69	0.04	0.02	0.03	0.00	0.00	14.40
2000	1.50	4.25	5.26	2.07	0.82	0.88	0.52	0.62	0.26	0.39	0.64	0.10	0.00	0.01	0.00	17.32
2001	0.68	1.78	14.31	12.75	3.71	1.23	0.63	0.52	0.59	0.13	0.54	1.21	0.09	0.06	0.04	38.27
2002	0.69	1.25	3.04	7.93	5.30	2.00	1.13	0.61	0.35	0.26	0.01	0.10	0.16	0.02	0.00	22.85
2003	0.55	1.12	0.72	1.86	4.47	1.66	0.20	0.05	0.09	0.01	0.00	0.01	0.02	0.01	0.01	10.78
2004	0.26	2.04	1.03	0.66	0.80	4.56	5.87	1.67	0.17	0.39	0.23	0.03	0.00	0.03	0.09	17.83
2005	0.93	1.18	3.09	2.28	0.83	0.47	0.80	0.57	0.22	0.03	0.19	0.09	0.04	0.04	0.11	10.87
2006																
2007	4.02	1.74	4.55	2.94	0.96	0.28	0.09	0.11	0.33	0.45	0.10	0.06	0.10	0.06	0.01	15.80
2008	0.59	5.07	4.16	3.32	1.39	0.68	0.47	0.13	0.06	0.07	0.10	0.05	0.02	0.00	0.00	16.11
2009	0.42	1.76	6.66	3.81	4.73	3.09	1.56	0.73	0.04	0.02	0.11	0.37	0.18	0.02	0.00	23.50
2010	0.71	2.38	7.53	14.46	4.69	2.40	0.92	0.37	0.03	0.05	0.05	0.11	0.01	0.00	0.00	33.71

Western 3Ps (Burgeo Area; 1993-2010)

Year/Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
1993 (Apr)	0.00	0.00	3.37	8.04	6.44	6.94	1.73	0.53	0.21	0.09	0.15	0.00	0.01	0.01	0.03	27.55
1994	0.00	0.00	4.84	9.73	15.76	8.60	6.26	2.89	0.51	0.16	0.08	0.06	0.02	0.03	0.03	48.94
1995	0.00	0.49	2.60	2.75	2.26	3.03	1.32	2.07	0.58	0.08	0.06	0.05	0.04	0.03	0.00	15.36
1996	0.42	1.37	10.48	12.50	4.87	5.84	6.11	1.17	1.50	0.03	0.17	0.00	0.00	0.00	0.00	44.46
1997	0.00	0.60	2.94	4.73	1.83	1.66	1.02	0.92	0.72	0.11	0.05	0.00	0.00	0.00	0.00	14.58
1998	0.00	0.42	26.74	25.99	28.22	18.46	13.65	6.28	2.43	0.40	2.10	0.00	0.00	0.00	0.00	124.69
1999	0.00	1.14	4.50	6.24	10.27	3.61	3.90	0.50	0.78	0.20	0.23	0.38	0.00	0.00	0.00	31.75
2000	0.41	0.71	4.31	6.56	6.52	7.81	6.20	1.95	0.95	0.08	0.00	0.15	0.00	0.00	0.00	35.65
2001	0.04	6.05	12.35	6.32	4.07	4.35	4.20	1.73	1.22	0.96	0.21	0.10	0.03	0.02	0.00	41.65
2002	0.16	0.83	6.61	9.91	7.77	8.86	6.97	3.09	1.37	0.92	0.32	0.15	0.11	0.00	0.00	47.07
2003	0.08	1.94	4.25	16.66	15.90	14.88	5.65	3.06	1.95	1.23	1.89	0.26	0.58	0.00	0.00	68.33
2004	0.00	1.68	6.22	6.14	8.89	3.75	2.59	0.73	0.66	0.46	0.48	0.15	0.03	0.15	0.00	31.93
2005	0.00	2.74	21.17	20.84	5.41	2.42	1.02	1.06	0.30	0.08	0.00	0.00	0.00	0.00	0.00	55.04
2006																
2007	0.00	0.27	0.50	7.85	3.77	3.90	2.17	2.41	0.90	0.38	0.19	0.48	0.00	0.00	0.00	22.82
2008	0.00	0.86	6.49	6.67	4.04	1.35	0.46	0.69	0.15	0.40	0.07	0.00	0.08	0.05	0.00	21.31
2009	0.00	0.99	29.13	15.73	11.91	2.25	2.44	1.00	0.31	0.19	0.19	0.28	0.04	0.00	0.00	64.46
2010	0.21	0.94	5.58	34.51	18.73	4.38	0.17	0.06	0.18	0.00	0.00	0.00	0.00	0.00	0.00	64.76

Table 12. Mean length-at-age (cm) of cod sampled during research bottom-trawl surveys in Subdivision 3Ps in winter-spring 1983-2010. Shaded entries are based on fewer than 5 aged fish.

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	10.3	12.0		11.0	10.7	9.2	12.0		9.5					12.6	12.7
2	20.2	19.2	17.9	18.8	19.9	19.7	19.2	19.9	19.2	20.7		19.1	21.2	20.8	24.1
3	31.2	30.7	29.1	27.1	29.5	29.0	30.2	29.9	29.8	30.4	30.9	32.2	29.9	30.0	31.8
4	43.1	42.1	40.3	40.3	39.5	40.7	41.7	40.1	39.0	40.9	41.3	39.4	42.0	38.7	40.9
5	52.9	52.2	51.2	49.0	48.4	47.8	48.2	48.3	47.0	47.4	48.0	48.2	50.4	44.2	48.2
6	57.8	60.7	60.2	55.7	54.1	56.2	56.3	53.7	53.5	55.3	52.7	50.2	56.5	52.9	51.6
7	65.6	66.2	66.4	62.1	61.2	62.2	64.0	56.6	57.4	61.2	62.3	53.7	58.2	60.9	60.7
8	71.5	70.6	74.2	72.2	67.3	66.7	71.8	62.3	62.8	62.4	70.6	59.1	57.9	61.2	65.4
9	73.4	75.5	73.9	76.4	77.8	74.6	75.9	70.1	68.2	66.7	77.1	68.0	63.0	63.3	67.3
10	79.4	79.1	79.4	82.8	85.4	79.7	84.6	76.2	73.7	73.3	80.2	87.7	79.6	76.8	67.3
11	89.6	84.2	88.9	93.3	83.2	79.7	88.5	79.1	73.8	83.9	96.0	79.7	81.3	74.7	82.5
12	93.7	98.1	93.0	93.9	89.9	87.5	96.6	88.7	77.1	81.8	106.0	90.5	83.6	86.1	

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	10.6	12.0	13.3	10.6	12.0	10.7	14.0	12.1		11.1	11.7	12.3	11.8
2	22.3	22.4	22.0	21.9	22.0	23.7	20.2	25.5		21.2	18.4	19.1	22.7
3	32.8	31.4	31.7	33.2	31.8	31.9	33.7	34.2		30.7	26.6	31.3	30.5
4	42.7	43.2	40.8	40.6	42.0	43.0	38.9	41.9		38.1	38.5	38.7	40.4
5	49.1	51.4	48.8	47.6	50.8	51.8	47.6	48.6		48.9	45.9	46.7	45.6
6	53.3	58.9	54.7	51.4	55.1	55.4	60.8	54.5		54.9	53.0	55.0	55.0
7	57.6	61.7	60.5	57.4	55.2	58.6	66.3	63.5		55.8	60.2	60.5	65.8
8	67.1	66.2	65.3	68.8	67.2	58.7	69.2	67.6		64.9	59.4	63.5	70.9
9	77.4	77.6	67.9	77.5	74.6	70.5	67.3	72.3		81.7	66.9	72.3	75.2
10	77.2	86.8	81.2	75.0	79.8	72.0	69.6	72.6		91.6	68.2	76.0	31.1
11	64.3	76.9	92.7	85.5	73.4	65.5	73.2	99.2		86.9	90.0	83.3	92.6
12	78.0	109.0	89.1	96.8	86.0	86.6	73.5	103.4		86.6	94.1	87.2	103.1

Table 13. Mean round weight-at-age (kg) of cod sampled during DFO bottom-trawl surveys in Subdivision 3Ps in winter-spring 1983-2010. Shaded entries are based on fewer than 5 aged fish.

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	0.01								0.01					0.02	0.02
2	0.07	0.07		0.05		0.06	0.06	0.06	0.05	0.06		0.05	0.06	0.07	0.11
3	0.22	0.25	0.21	0.17	0.23	0.19	0.24	0.20	0.20	0.22	0.21	0.23	0.20	0.22	0.26
4	0.66	0.63	0.49	0.45	0.52	0.56	0.58	0.52	0.45	0.54	0.54	0.44	0.52	0.46	0.54
5	1.29	1.13	1.05	0.87	0.92	0.88	0.91	0.96	0.84	0.89	0.86	0.87	0.93	0.71	0.88
6	1.59	1.84	1.60	1.36	1.32	1.42	1.28	1.36	1.33	1.44	1.20	1.08	1.50	1.21	1.15
7	2.15	2.74	2.30	2.39	1.88	2.17	2.25	1.62	1.74	2.06	2.05	1.33	1.75	2.04	1.87
8	3.44	3.84	3.19	3.25	2.41	2.51	3.74	2.19	2.37	2.32	3.13	1.87	1.75	2.19	2.64
9	3.87	4.26	3.31	5.42	4.33	4.08	4.57	3.21	3.09	2.91	4.48	3.03	2.28	2.41	3.06
10	5.22	5.06	3.76	4.41	6.35	4.77	5.95	4.33	4.08	4.15	4.47	6.35	4.88	4.46	3.22
11	8.81	8.09		6.42	6.74	4.21	8.78	5.09	4.10	5.90	8.53	5.21	5.50	3.99	5.46
12	10.34	10.03	3.97	9.16	6.11	9.43	8.88	7.46	5.09	5.81	13.20	7.47	6.49	7.01	

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	0.01	0.01	0.02	0.01	0.01	0.01	0.02	0.01		0.01	0.01	0.01	0.01
2	0.09	0.10	0.08	0.08	0.09	0.10	0.07	0.14		0.08	0.05	0.05	0.09
3	0.28	0.28	0.27	0.28	0.24	0.27	0.31	0.34		0.23	0.16	0.24	0.22
4	0.62	0.64	0.57	0.55	0.56	0.61	0.50	0.62		0.46	0.47	0.47	0.52
5	0.99	1.10	0.92	0.87	1.01	1.10	0.86	1.00		0.95	0.80	0.79	0.79
6	1.27	1.72	1.35	1.16	1.39	1.46	1.81	1.37		1.44	1.18	1.39	1.40
7	1.63	2.08	1.90	1.67	1.45	1.83	2.47	2.24		1.57	1.85	1.96	2.51
8	2.74	2.57	2.51	2.96	2.75	1.74	3.15	3.12		2.54	1.88	2.42	3.24
9	4.76	4.39	2.91	4.39	4.00	3.15	2.95	4.06		5.34	2.78	3.68	4.24
10	5.07	6.87	5.19	4.35	5.11	3.76	3.34	4.47		8.17	3.29	4.27	6.96
11	2.68	5.12	8.34	6.09	4.20	2.64	4.25	10.31		7.66	7.21	6.26	9.05
12	5.25	13.16	8.13	9.05	6.24	6.56	4.71	11.30		7.82	9.11	7.07	11.31

Table 14. Parameter estimates and SE's for a probit model fitted to observed proportions mature at age (from "combined" survey area) for female cod from NAFO Subdivision 3Ps based on surveys conducted during 1959-2010 (nf=no significant model fit).

Cohort	slope	slope_SE	intercept	intercept_se	Cohort	slope	slope_SE	intercept	intercept_se
1954	1.1094	0.2940	-8.1702	2.4445	1982	2.0091	0.2059	-13.3056	1.3496
1955	1.5059	0.2237	-10.2633	1.6124	1983	1.8944	0.2608	-11.8903	1.6045
1956	1.3174	0.3208	-9.4592	2.2216	1984	2.2315	0.2981	-13.4166	1.8044
1957	1.4604	0.3703	-10.3248	2.3525	1985	2.6988	0.3728	-16.0342	2.2010
1958	2.3929	0.5853	-16.4519	3.6202	1986	2.5829	0.2930	-14.0673	1.5934
1959	2.1113	0.5358	-13.0196	2.9364	1987	2.2526	0.2231	-11.9227	1.2350
1960	1.6741	0.2990	-10.6677	1.7584	1988	2.7731	0.4110	-14.0212	2.1672
1961	1.8639	0.3551	-11.4722	2.0669	1989	1.8846	0.1577	-9.7844	0.8110
1962	1.7141	0.2898	-10.5115	1.7043	1990	1.7888	0.1900	-9.2101	0.9575
1963			nf		1991	2.4874	0.4971	-13.1443	2.5618
1964	1.9272	0.2411	-12.7182	1.5667	1992	2.6015	0.3903	-13.0008	1.9108
1965	2.4194	0.5982	-16.4244	4.2387	1993	1.8954	0.2394	-9.8698	1.2957
1966	1.5492	0.2401	-10.0608	1.6025	1994	1.6015	0.1969	-8.1481	1.0091
1967	1.6876	0.3782	-10.0845	2.2543	1995	1.6523	0.2188	-8.7711	1.1242
1968	2.1397	0.2885	-13.1625	1.7869	1996	1.7414	0.2410	-9.3461	1.2620
1969	1.6825	0.3043	-10.3672	1.8439	1997	3.0797	0.4567	-14.8462	2.1742
1970	1.5265	0.2305	-8.8558	1.3136	1998	1.9984	0.2396	-9.6586	1.1567
1971	1.3122	0.1401	-7.8405	0.8346	1999	1.8423	0.2647	-9.1495	1.3103
1972	1.4117	0.1445	-8.9081	0.8853	2000	1.7800	0.3025	-9.2716	1.4885
1973	1.4521	0.1667	-9.3550	1.0320	2001	1.7588	0.2292	-8.3449	1.0333
1974	2.0042	0.1969	-13.1541	1.2944	2002	1.6740	0.2447	-8.8385	1.2984
1975	1.7846	0.2174	-11.1641	1.3757	2003	1.5295	0.2370	-8.7382	1.3221
1976	1.3552	0.2056	-8.5990	1.2510	2004	2.1559	0.3191	-11.51907	1.655
1977	2.5066	0.3505	-15.3640	2.1732	2005	3.3137	0.8844	-16.68502	4.3182
1978	1.7920	0.1680	-10.7323	1.0205					
1979	1.0297	0.1138	-6.4477	0.7670					
1980	1.4270	0.1415	-9.4134	0.9131					
1981	1.7431	0.1781	-11.9865	1.1846					

Table 15. Estimated proportions mature for female cod from NAFO Subdivision 3Ps from DFO surveys from 1978 to 2010 projected forward to 2012. Estimates were obtained from a probit model fitted by cohort to observed proportions mature at age (from "combined" survey area). Shaded cells are averages of the three closest cohorts; boxed cells are the average of estimates for the adjacent cohorts.

| Year/Age	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Age 12	Age 13	Age 14
1954	0.0288	0.0000	0.0328	0.0592	0.1059	0.1866	0.3097	0.7249	0.8832	0.9407	0.9697	0.9842	0.9917	0.9955
1955	0.0009	0.0515	0.0000	0.0592	0.1059	0.1866	0.3097	0.7249	0.8832	0.9407	0.9697	0.9842	0.9917	0.9955
1956	0.0002	0.0026	0.0905	0.0000	0.1059	0.1866	0.3097	0.7249	0.8832	0.9407	0.9697	0.9842	0.9917	0.9955
1957	0.0003	0.0007	0.0078	0.1541	0.0000	0.1866	0.3097	0.7249	0.8832	0.9407	0.9697	0.9842	0.9917	0.9955
1958	0.0001	0.0011	0.0032	0.0234	0.2502	0.0000	0.3097	0.7249	0.8832	0.9407	0.9697	0.9842	0.9917	0.9955
1959	0.0000	0.0006	0.0040	0.0142	0.0677	0.3793	0.0006	0.7249	0.8832	0.9407	0.9697	0.9842	0.9917	0.9955
1960	0.0000	0.0000	0.0026	0.0149	0.0610	0.1804	0.5281	0.8333	0.8832	0.9407	0.9697	0.9842	0.9917	0.9955
1961	0.0001	0.0002	0.0001	0.0112	0.0536	0.2266	0.4003	0.6721	1.0000	0.9407	0.9697	0.9842	0.9917	0.9955
1962	0.0001	0.0007	0.0012	0.0010	0.0464	0.1744	0.5691	0.6693	0.7697	1.0000	0.9697	0.9842	0.9917	0.9955
1963	0.0002	0.0004	0.0035	0.0102	0.0111	0.1733	0.4410	0.8562	0.8599	0.8731	1.0000	0.9842	0.9917	0.9955
1964	0.0001	0.0008	0.0028	0.0185	0.0785	0.1096	0.4745	0.7465	0.9641	0.9490	0.9285	1.0000	0.9917	0.9966
1965	0.0000	0.0005	0.0046	0.0177	0.0914	0.4130	0.5741	0.7955	0.9166	0.9918	0.9826	0.9585	1.0000	0.9955
1966	0.0000	0.0001	0.0028	0.0252	0.1041	0.3491	0.8532	0.9365	0.9437	0.9762	0.9982	0.9942	0.9789	1.0000
1967	0.0002	0.0000	0.0010	0.0159	0.1255	0.4283	0.7410	0.9796	0.9938	0.9663	0.9935	0.9996	0.9981	0.9872
1968	0.0002	0.0009	0.0001	0.0066	0.0847	0.4435	0.8285	0.9385	0.9975	0.9994	0.9968	0.9983	0.9999	0.9994
1969	0.0000	0.0012	0.0044	0.0012	0.0438	0.3415	0.8157	0.9689	0.9879	0.9997	0.9999	0.9993	0.9995	1.0000
1970	0.0002	0.0001	0.0066	0.0205	0.0130	0.2395	0.7498	0.9609	0.9950	0.9977	1.0000	1.0000	0.9998	0.9999
1971	0.0007	0.0009	0.0012	0.0344	0.0899	0.1292	0.6839	0.9489	0.9927	0.9992	0.9996	1.0000	1.0000	1.0000
1972	0.0015	0.0030	0.0049	0.0099	0.1616	0.3174	0.6250	0.9370	0.9915	0.9987	0.9999	0.9999	1.0000	1.0000
1973	0.0006	0.0054	0.0137	0.0257	0.0784	0.5103	0.6864	0.9493	0.9903	0.9986	0.9996	1.0000	1.0000	1.0000
1974	0.0004	0.0023	0.0198	0.0601	0.1241	0.4196	0.8493	0.9115	0.9953	0.9986	0.9998	1.0000	1.0000	1.0000
1975	0.0000	0.0016	0.0093	0.0697	0.2273	0.4324	0.8600	0.9682	0.9798	0.9996	0.9998	1.0000	1.0000	1.0000
1976	0.0001	0.0001	0.0067	0.0369	0.2176	0.5752	0.8038	0.9812	0.9940	0.9956	1.0000	1.0000	1.0000	1.0000
1977	0.0007	0.0005	0.0008	0.0280	0.1359	0.5081	0.8617	0.9566	0.9978	0.9989	0.9991	1.0000	1.0000	1.0000
1978	0.0000	0.0028	0.0030	0.0058	0.1096	0.3922	0.7933	0.9663	0.9916	0.9997	0.9998	0.9998	1.0000	1.0000
1979	0.0001	0.0000	0.0106	0.0175	0.0418	0.3447	0.7259	0.9344	0.9925	0.9984	1.0000	1.0000	1.0000	1.0000
1980	0.0044	0.0008	0.0004	0.0400	0.0961	0.2444	0.6921	0.9157	0.9815	0.9984	0.9997	1.0000	1.0000	1.0000
1981	0.0003	0.0123	0.0047	0.0048	0.1391	0.3878	0.7059	0.9057	0.9781	0.9949	0.9996	0.9999	1.0000	1.0000
1982	0.0000	0.0014	0.0336	0.0275	0.0557	0.3852	0.7905	0.9468	0.9762	0.9946	0.9986	0.9999	1.0000	1.0000
1983	0.0000	0.0002	0.0059	0.0888	0.1452	0.4197	0.7084	0.9574	0.9925	0.9943	0.9987	0.9996	1.0000	1.0000
1984	0.0000	0.0001	0.0012	0.0240	0.2143	0.5049	0.8987	0.9040	0.9926	0.9990	0.9987	0.9997	0.9999	1.0000
1985	0.0000	0.0003	0.0007	0.0066	0.0929	0.4331	0.8595	0.9909	0.9734	0.9987	0.9999	0.9997	0.9999	1.0000
1986	0.0000	0.0001	0.0020	0.0051	0.0366	0.2991	0.6814	0.9735	0.9993	0.9930	0.9998	1.0000	0.9999	1.0000
1987	0.0000	0.0000	0.0012	0.0132	0.0370	0.1783	0.6400	0.8569	0.9955	0.9999	0.9982	1.0000	1.0000	1.0000
1988	0.0001	0.0001	0.0004	0.0111	0.0818	0.2225	0.5536	0.8811	0.9437	0.9992	1.0000	0.9995	1.0000	1.0000
1989	0.0000	0.0006	0.0018	0.0053	0.0946	0.3719	0.6809	0.8764	0.9686	0.9792	0.9999	1.0000	0.9999	1.0000
1990	0.0004	0.0002	0.0057	0.0233	0.0731	0.4931	0.7975	0.9409	0.9759	0.9923	0.9925	1.0000	1.0000	1.0000
1991	0.0006	0.0024	0.0033	0.0515	0.2400	0.5396	0.9006	0.9632	0.9916	0.9957	0.9981	0.9973	1.0000	1.0000
1992	0.0000	0.0036	0.0158	0.0507	0.3408	0.8069	0.9457	0.9883	0.9943	0.9989	0.9992	0.9996	0.9990	1.0000
1993	0.0000	0.0003	0.0210	0.0957	0.4612	0.8310	0.9822	0.9962	0.9987	0.9991	0.9998	0.9999	0.9999	0.9997
1994	0.0003	0.0004	0.0034	0.1136	0.4106	0.9320	0.9791	0.9986	0.9997	0.9999	0.9999	1.0000	1.0000	1.0000
1995	0.0014	0.0023	0.0055	0.0394	0.4339	0.8210	0.9955	0.9978	0.9999	1.0000	1.0000	1.0000	1.0000	1.0000
1996	0.0008	0.0071	0.0150	0.0695	0.3302	0.8209	0.9679	0.9997	0.9998	1.0000	1.0000	1.0000	1.0000	1.0000
1997	0.0005	0.0042	0.0341	0.0921	0.5017	0.8557	0.9648	0.9950	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1998	0.0000	0.0028	0.0216	0.1490	0.4030	0.9314	0.9862	0.9939	0.9992	1.0000	1.0000	1.0000	1.0000	1.0000
1999	0.0005	0.0002	0.0160	0.1032	0.4649	0.8180	0.9946	0.9988	0.9990	0.9999	1.0000	1.0000	1.0000	1.0000
2000	0.0007	0.0035	0.0037	0.0847	0.3753	0.8117	0.9676	0.9996	0.9999	0.9998	1.0000	1.0000	1.0000	1.0000
2001	0.0006	0.0042	0.0250	0.0740	0.3455	0.7582	0.9553	0.9950	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2002	0.0014	0.0033	0.0260	0.1591	0.6347	0.7507	0.9424	0.9907	0.9992	1.0000	1.0000	1.0000	1.0000	1.0000
2003	0.0008	0.0079	0.0192	0.1443	0.5826	0.9742	0.9450	0.9884	0.9981	0.9999	1.0000	1.0000	1.0000	1.0000
2004	0.0007	0.0041	0.0444	0.1042	0.5155	0.9115	0.9988	0.9899	0.9978	0.9996	1.0000	1.0000	1.0000	1.0000
2005	0.0001	0.0034	0.0215	0.2125	0.4082	0.8704	0.9870	0.9999	0.9982	0.9996	0.9999	1.0000	1.0000	1.0000
2006	0.0000	0.0007	0.0155	0.1050	0.6104	0.8035	0.9769	0.9982	1.0000	0.9997	0.9999	1.0000	1.0000	1.0000
2007	0.0003	0.0000	0.0064	0.0678	0.3850	0.9010	0.9604	0.9963	0.9998	1.0000	0.9999	1.0000	1.0000	1.0000
2008	0.0003	0.0014	0.0012	0.0524	0.2515	0.7695	0.9814	0.9931	0.9994	1.0000	1.0000	1.0000	1.0000	1.0000
2009	0.0003	0.0014	0.0077	0.0314	0.3231	0.6080	0.9468	0.9967	0.9988	0.9999	1.0000	1.0000	1.0000	1.0000
2010	0.0003	0.0014	0.0077	0.0505	0.4709	0.8048	0.8774	0.9896	0.9994	0.9998	1.0000	1.0000	1.0000	1.0000
2011	0.0003	0.0014	0.0077	0.0505	0.3485	0.9607	0.9727	0.9706	0.9980	0.9999	1.0000	1.0000	1.0000	1.0000
2012	0.0003	0.0014	0.0077	0.0505	0.3485	0.7912	0.9985	0.9968	0.9935	0.9996	1.0000	1.0000	1.0000	1.0000
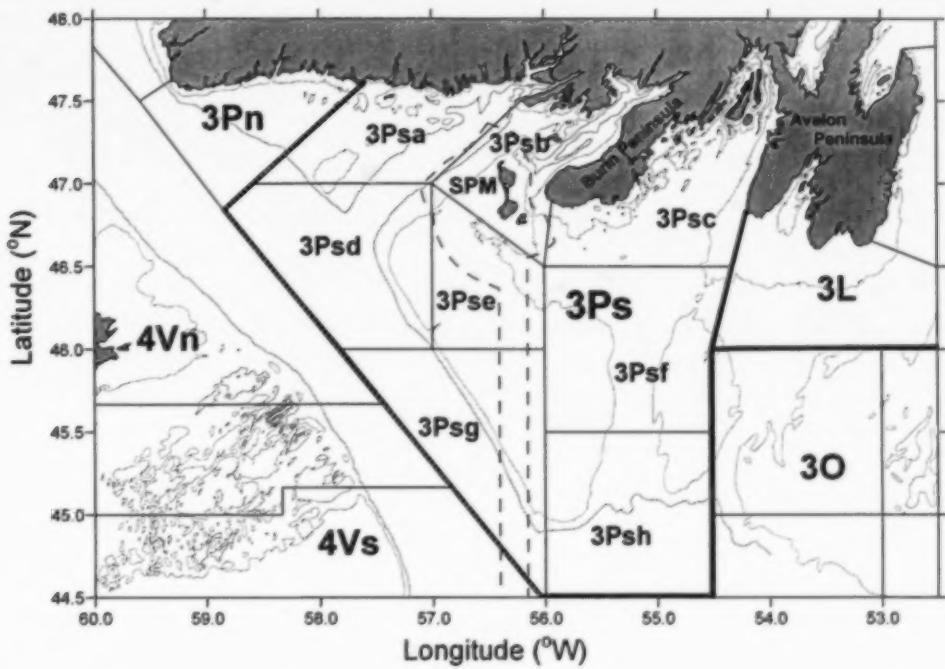
Figure 1. NAFO Subdivision 3Ps management zone showing the economic zone around the French islands of St. Pierre and Miquelon (SPM, dashed line), the 100 m and 250 m depth contours (grey lines) and the boundaries of the statistical unit areas (solid lines).
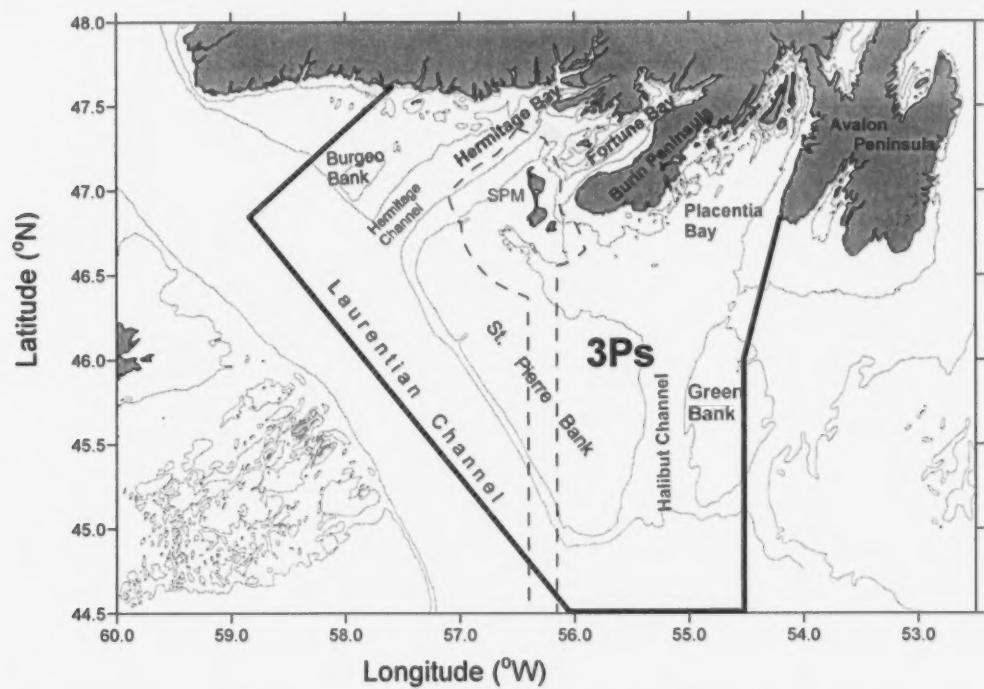
Figure 2. NAFO Subdivision 3Ps management zone showing the economic zone around the French islands of St. Pierre and Miquelon (SPM, dashed line), the 100 m and 250 m depth contours (grey lines) and the main fishing areas.
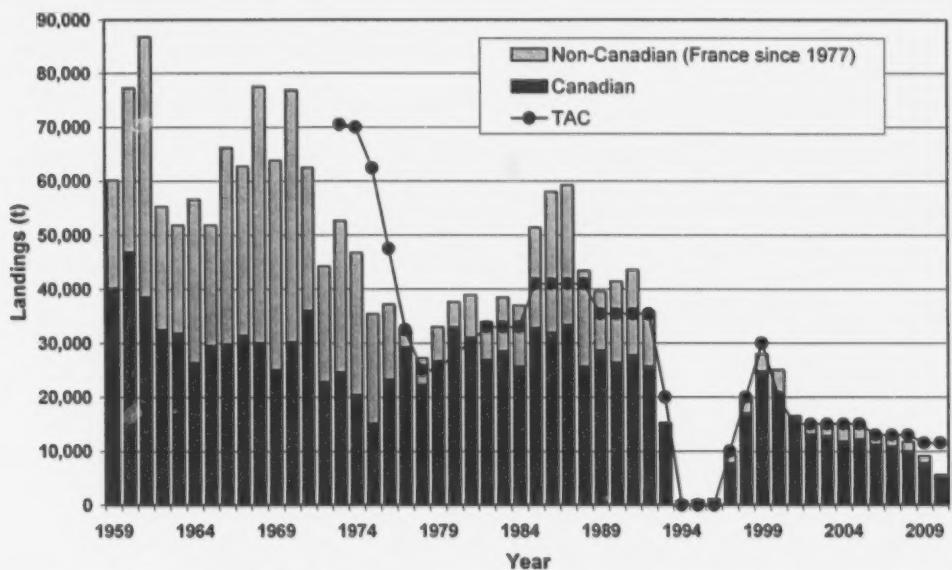
Figure 3a. Reported landings of cod by Canadian and non-Canadian vessels in NAFO Subdivision 3Ps during 1959-October 2010. The 2010 fishery was still in progress at the time of the October 2010 assessment.
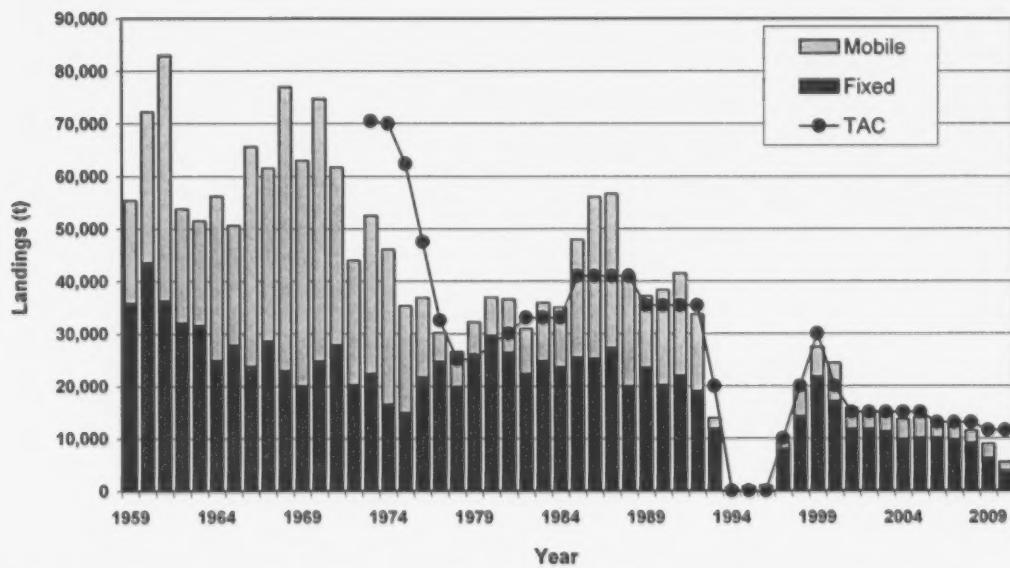
Figure 3b. Reported landings of cod by fixed and mobile gears in NAFO Subdivision 3Ps during 1959-October 2010. The 2010 fishery was still in progress at the time of the October 2009 assessment.
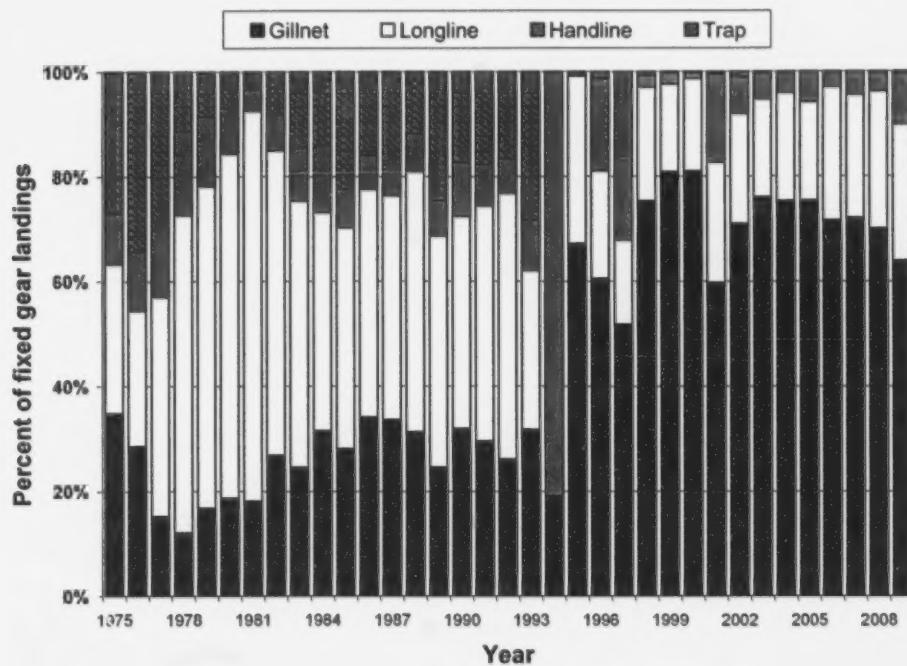
Figure 4. Percent of total fixed gear landings by the four main fixed gears used in the cod fishery in NAFO Subdivision 3Ps during 1975-2009. (Excludes values for 2010 as the fishery was still in progress.) The fishery was under a moratorium during 1994-96 and values for those years are based on sentinel and by-catch landings of <800 t.
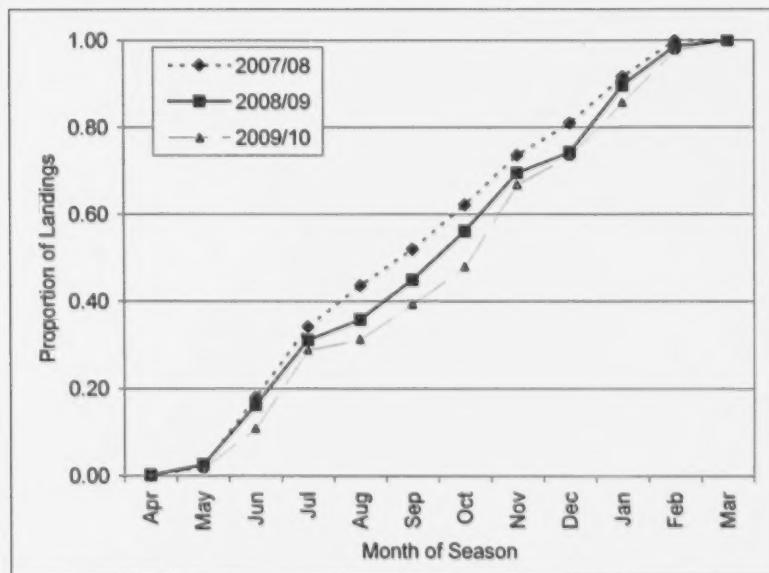
Figure 5. Proportion of landings by month of management year (April 1st – March 31st).
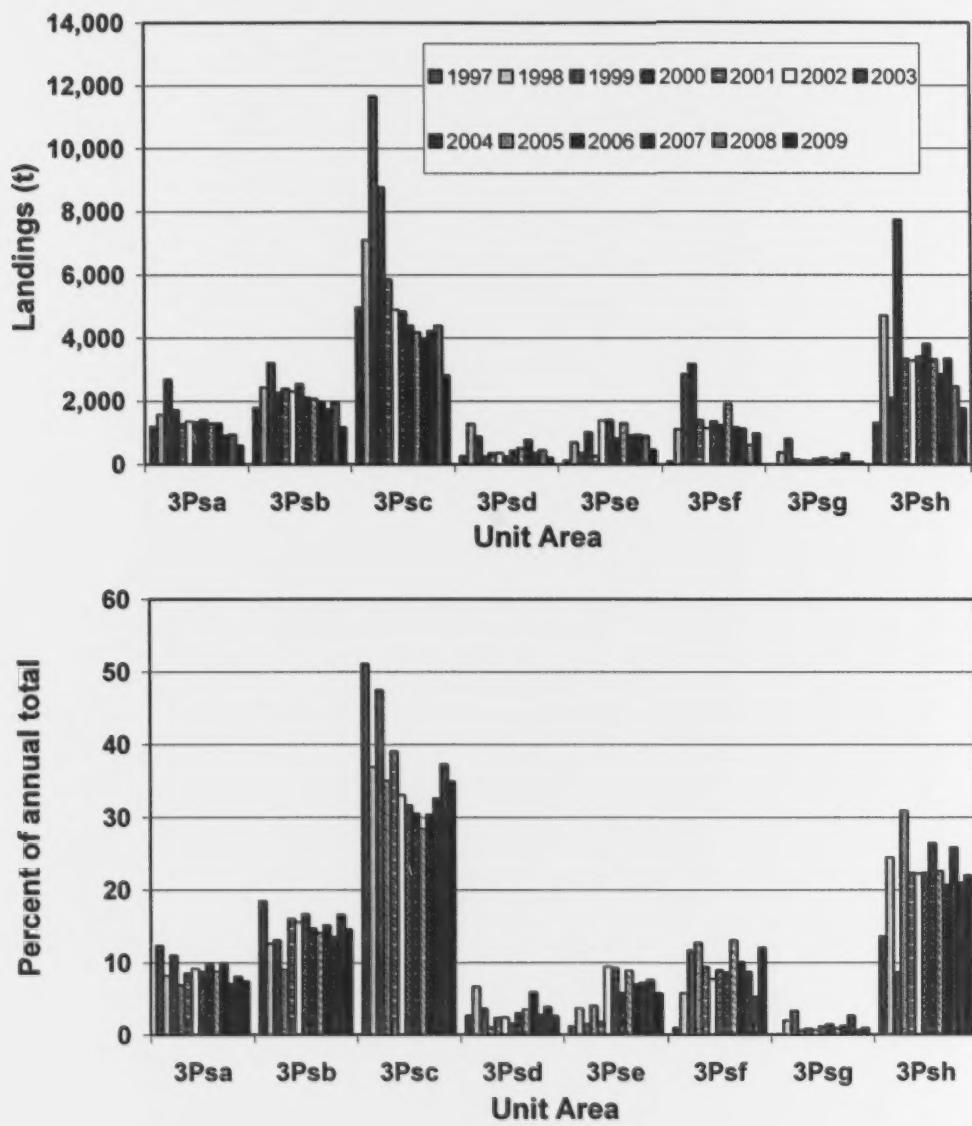
Figure 6. Annual reported landings of cod (upper panel) and percent of annual total (lower panel) by unit area from NAFO Subdivision 3Ps during 1997-2009. Refer to Figure 1 for locations of unit areas.
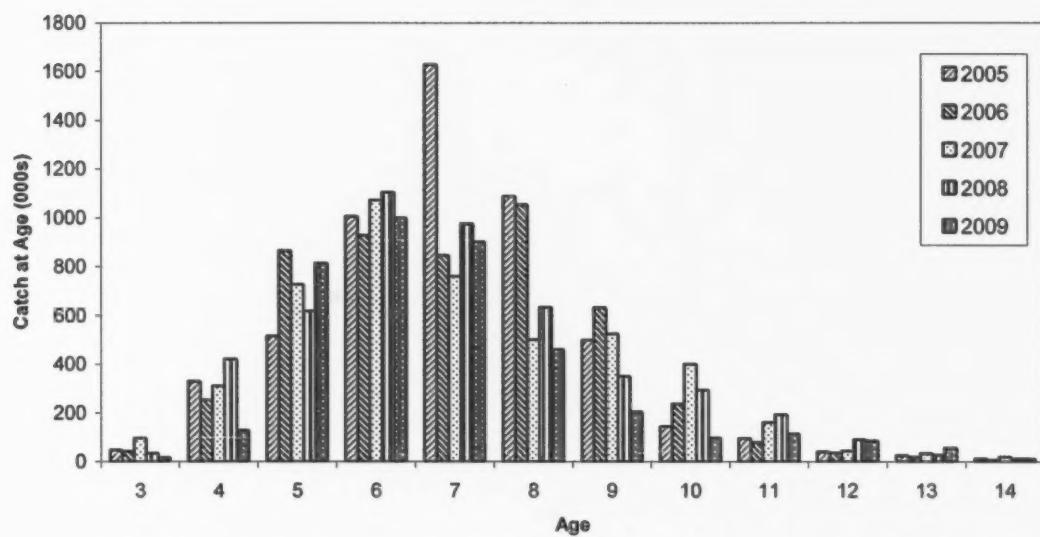
Figure 7a. Catch at age (numbers of fish; in thousands) for the cod fishery in 3Ps during 2005-09. Does not include recreational catches from 2007 onward (see text).
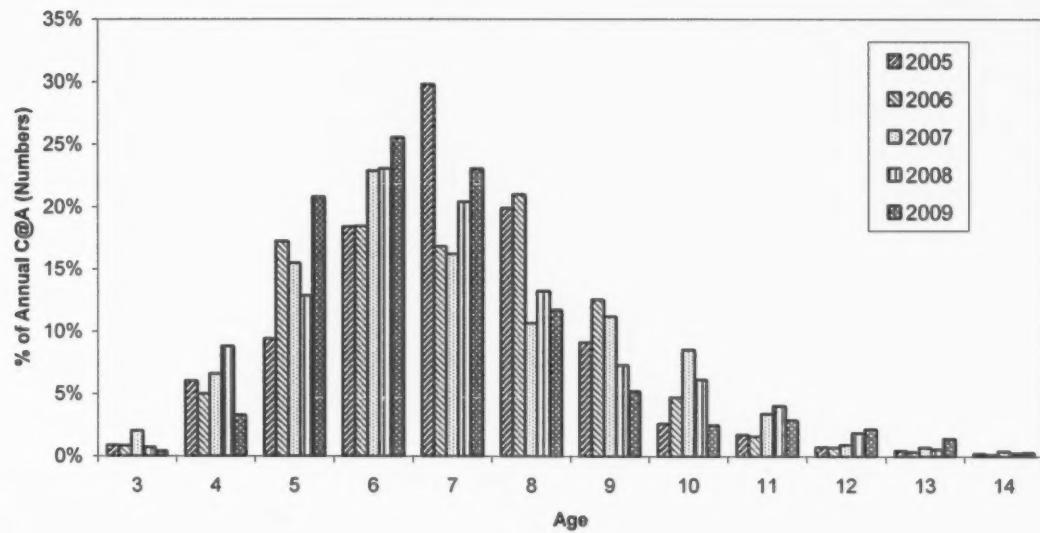
Figure 7b. Percent catch at age for 3Ps cod from 2005 to 2009.
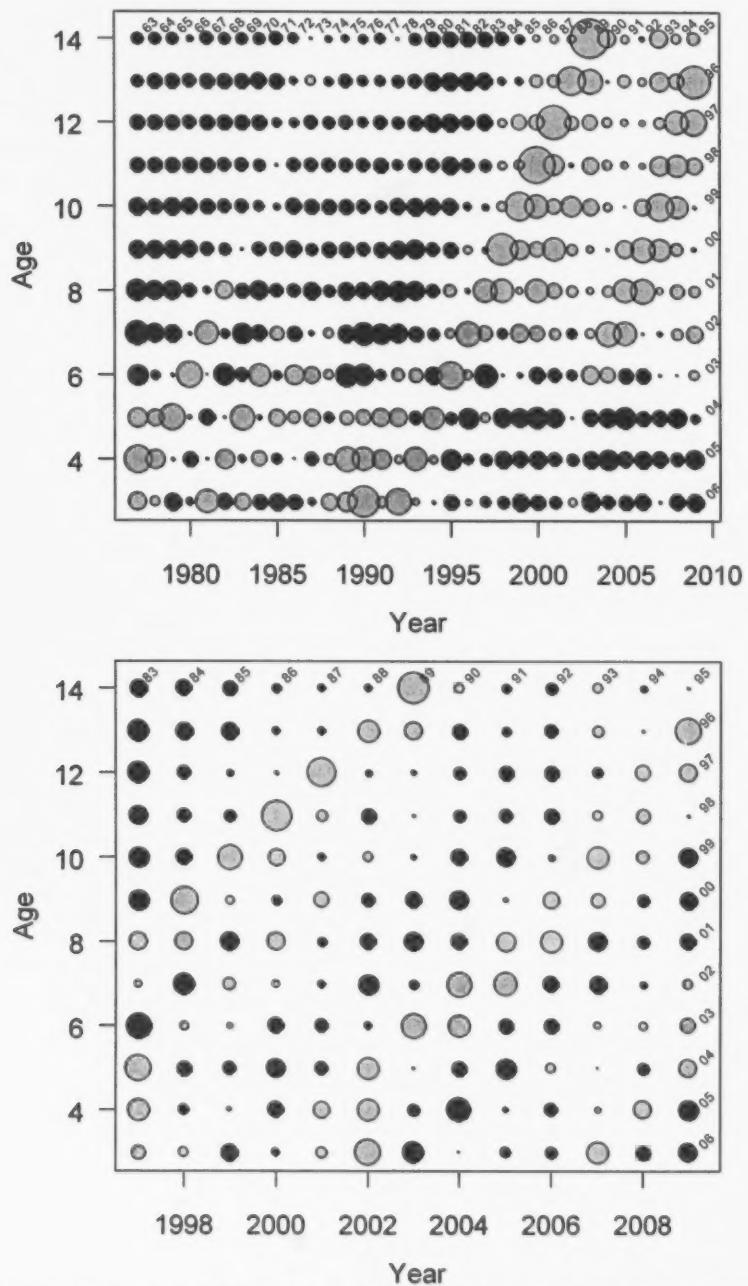
Figure 7c. Standardized proportions at age of commercial catch at age in Subdivision 3Ps. Catch proportions within each year were computed, and then standardized by subtracting the mean proportion and dividing by the standard deviation of the proportions across years. Symbol sizes are scaled and values greater than average are shown as grey circles, average values are shown as small dots, and less than average values are shown as black circles. Labels in the upper and right margins identify cohorts. Upper panel shows catches from 1977 to 2010; lower panel uses catch from post-moratorium period (1997-2010).
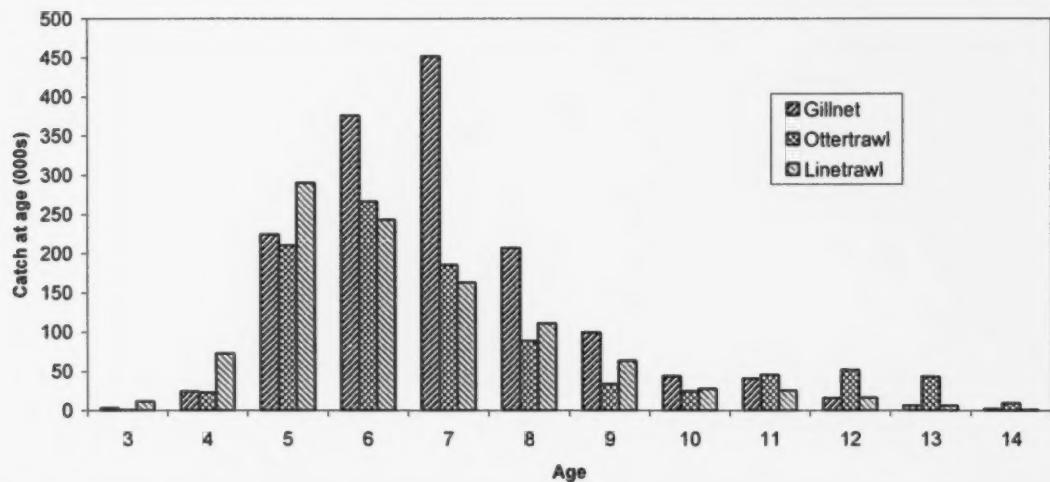
Figure 8. Catch numbers-at-age for the main gear types used in the 3Ps cod fishery during 2009.
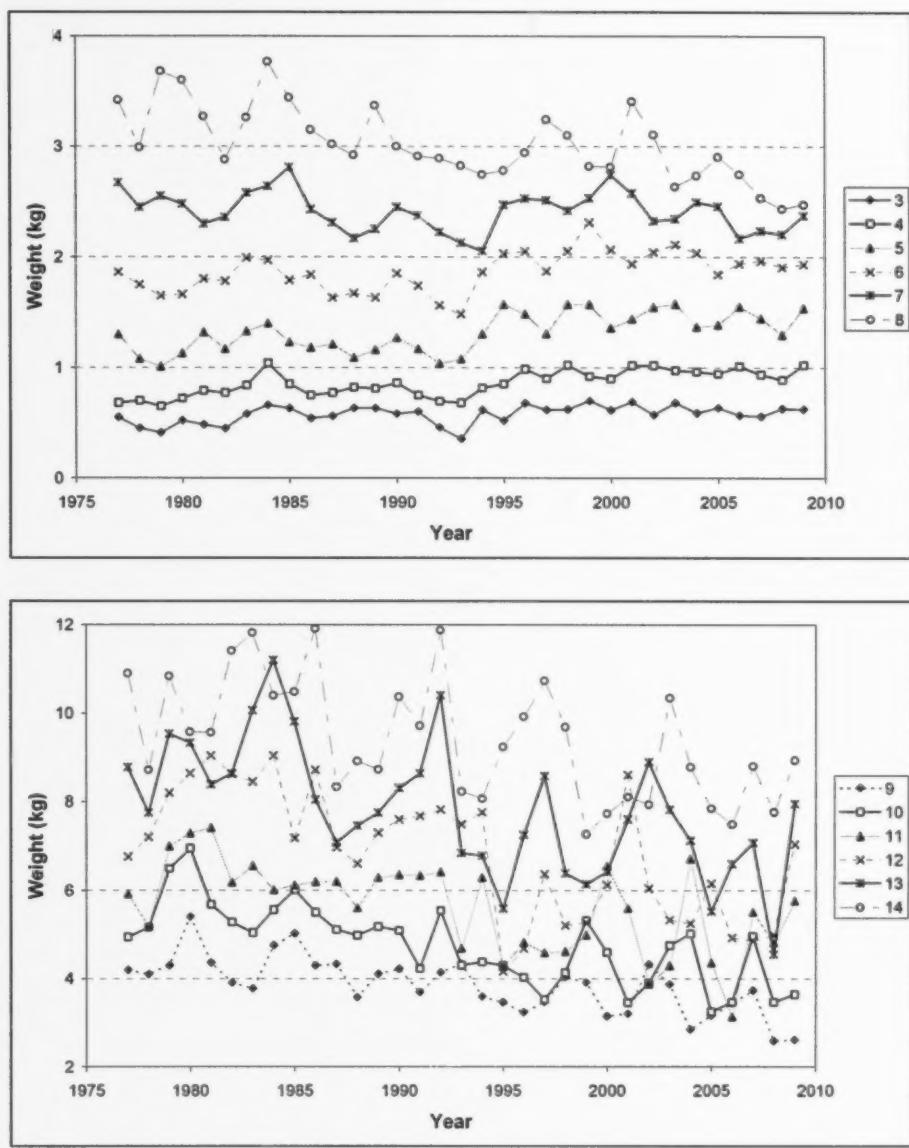
Figure 9. Mean weights-at-age calculated from mean lengths-at-age (upper panel: ages 3-8; lower panel: ages 9-14) for the commercial catch of cod in NAFO Subdivision 3Ps during 1977-2009.
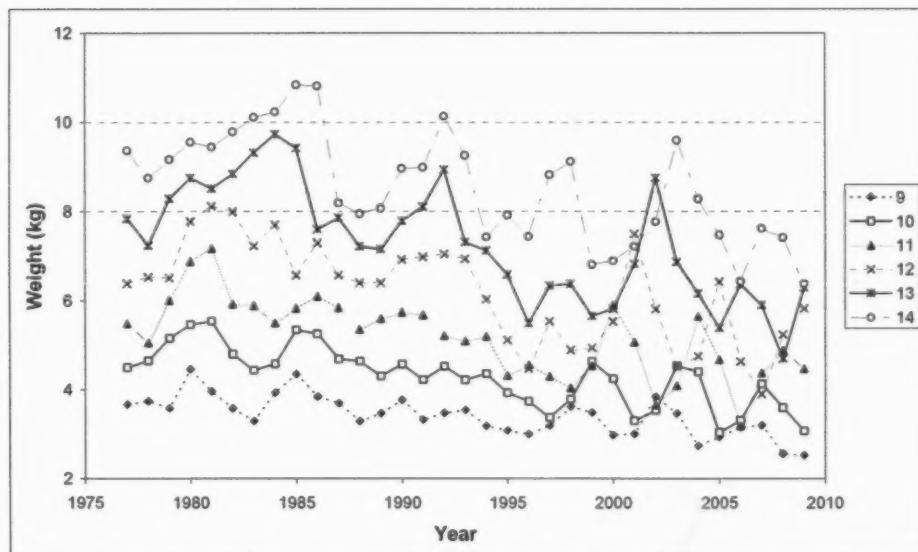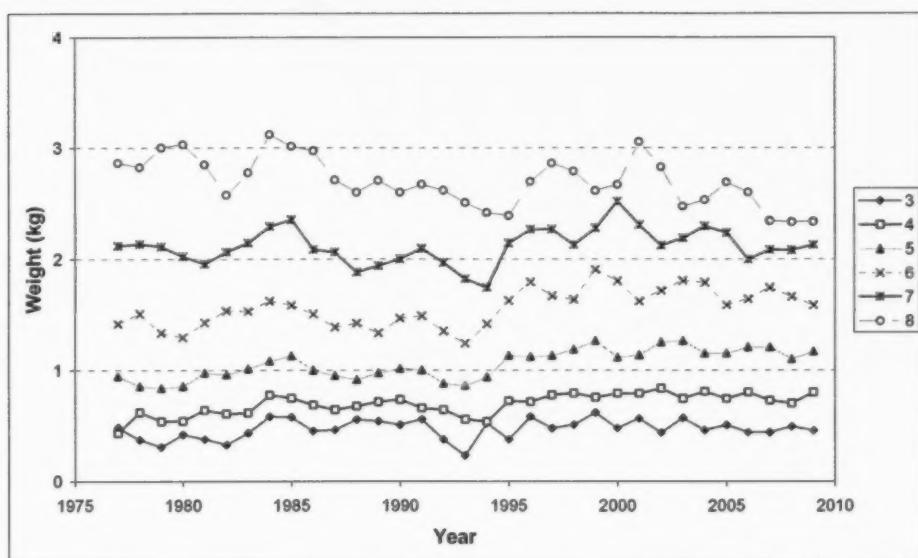
Figure 10. Beginning of year mean weights-at-age (upper panel: ages 3-8; lower panel: ages 9-14) from the commercial catch of cod in NAFO Subdivision 3Ps during 1977-2009.
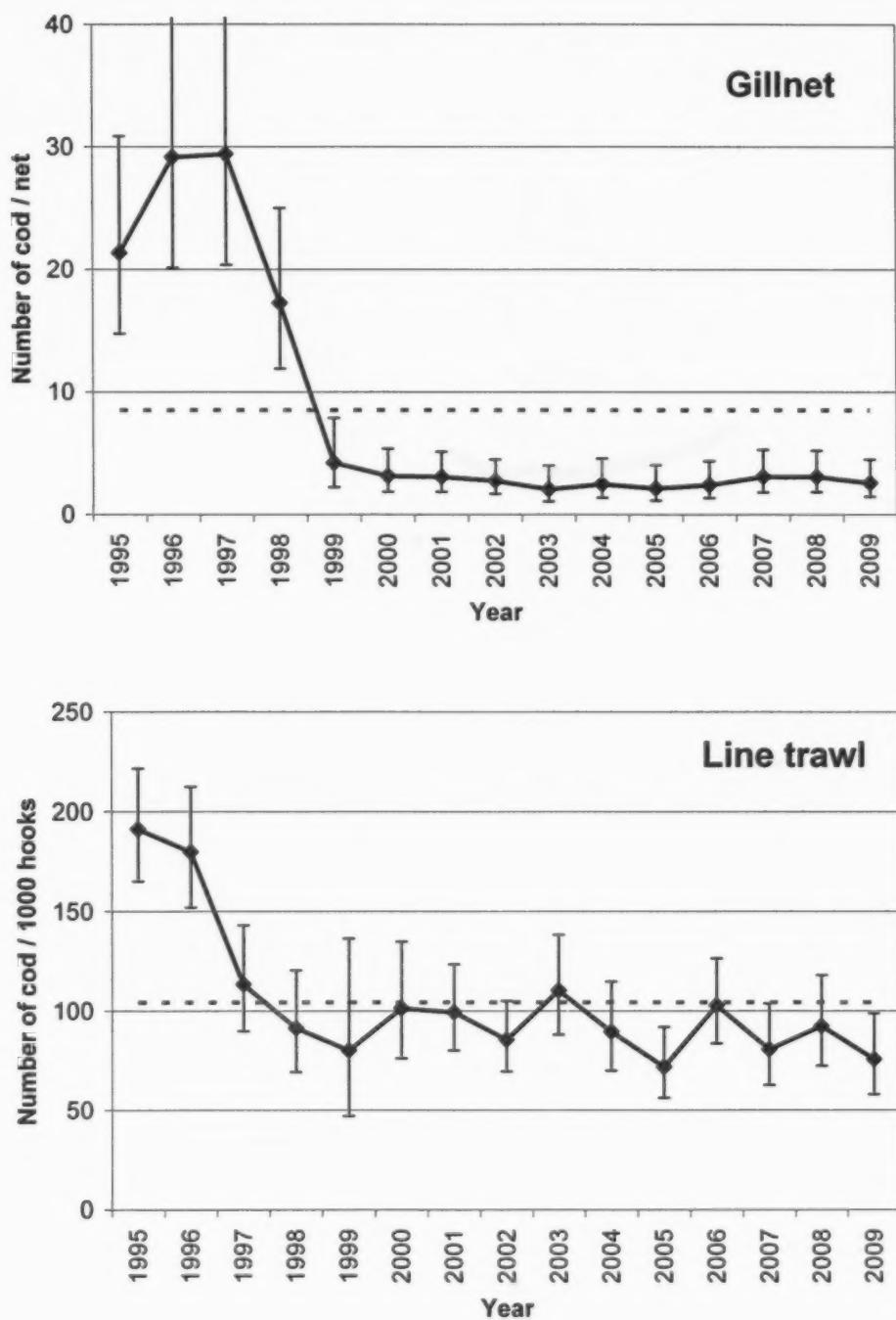
Figure 11a. Standardized age-aggregated catch rate indices for gillnets (5.5" mesh) and line-trawls (with 95% CL's) estimated using data from sentinel fishery fixed sites. Dashed horizontal lines indicate time-series average.
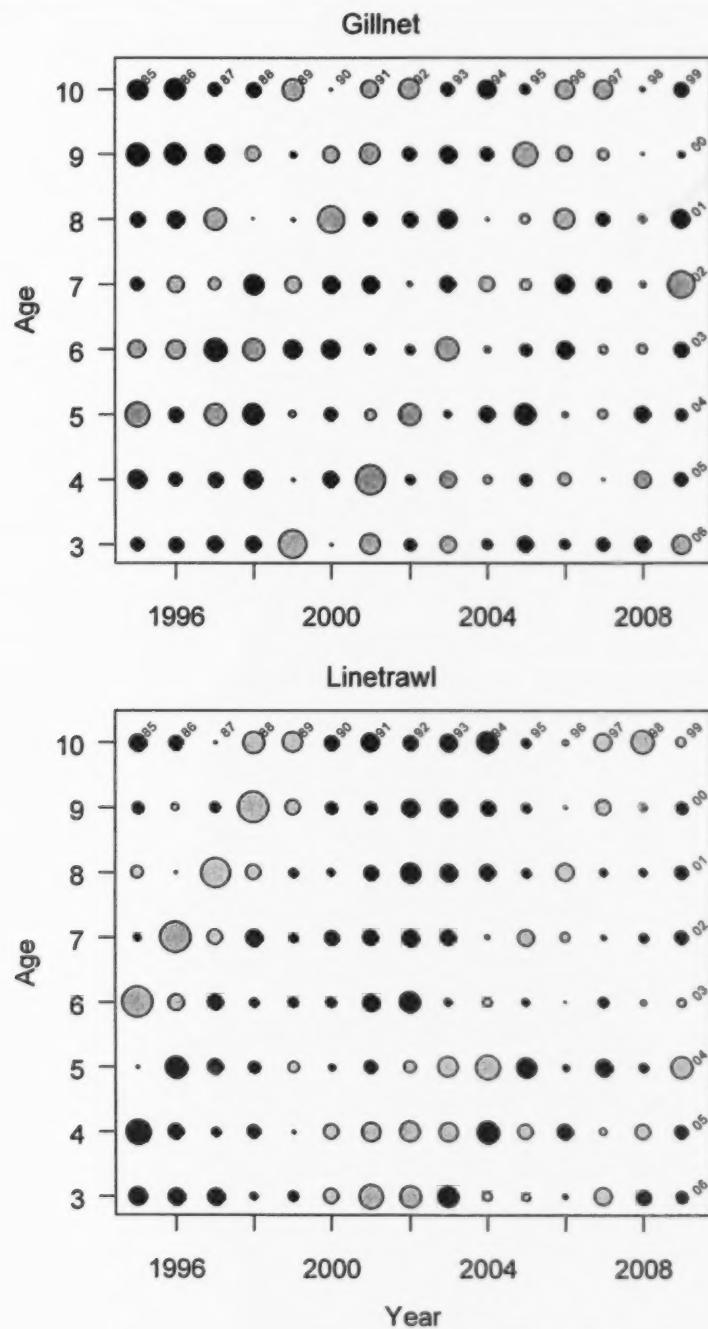
Figure 11b. Standardized proportions at age of sentinel catch rates at age in Subdivision 3Ps. Annual proportions were computed, and then standardized by subtracting the mean proportion and dividing by the standard deviation of the proportions across years. Symbol sizes are scaled and values greater than average are shown as grey circles, average values are shown as small dots, and less than average values are shown as black circles. Labels in the upper and right margins identify cohorts.
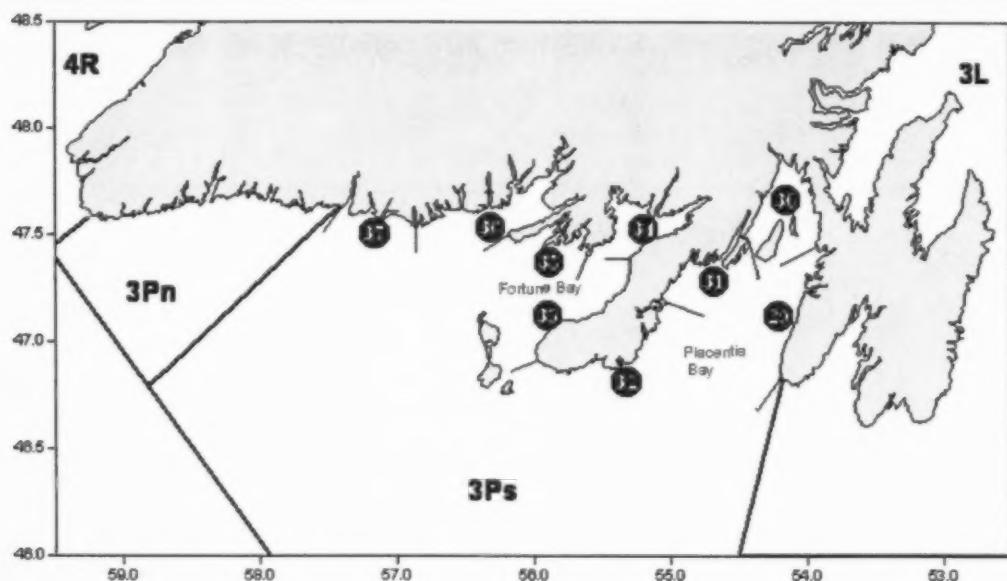
Figure 12a. Location and boundaries of numbered management areas along the inshore of the south coast of Newfoundland (NAFO Subdivision 3Ps) (29=Placentia Bay East, 30=Head of Placentia Bay, 31=Placentia Bay West, 32=The Boot, 33=Fortune Bay, 34=Head of Fortune Bay, 35=Connaigre, 36=Hermitage Bay, 37=Francois-Burgeo).
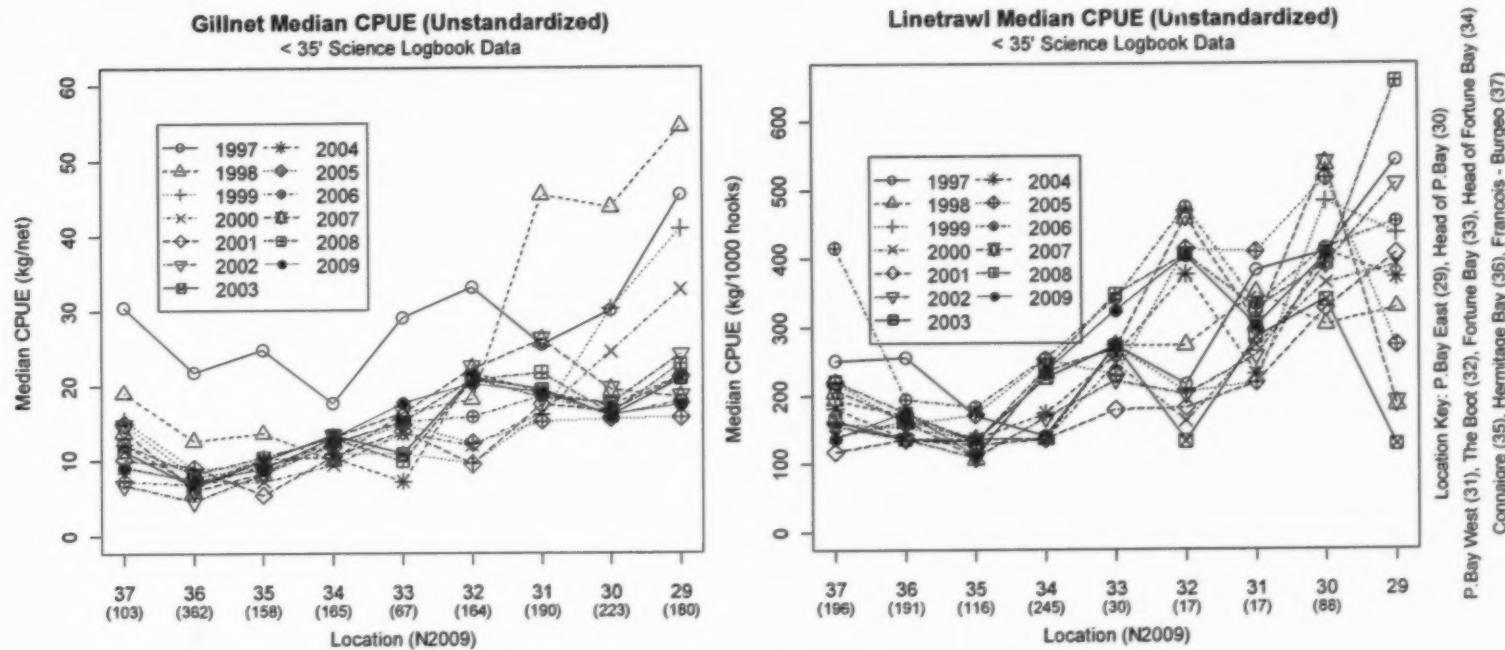
Figure 12b. Area-specific median annual catch rates of cod from gillnets (left panel, kg per net) and line-trawls (right panel, kg per 1,000 hooks) from science log-books for vessels <35 ft. Labels on x-axis are lobster fishing areas ordered from west to east (see key on far right). Values in parenthesis on x-axis are number of valid sets per site during the 2009 fishery.
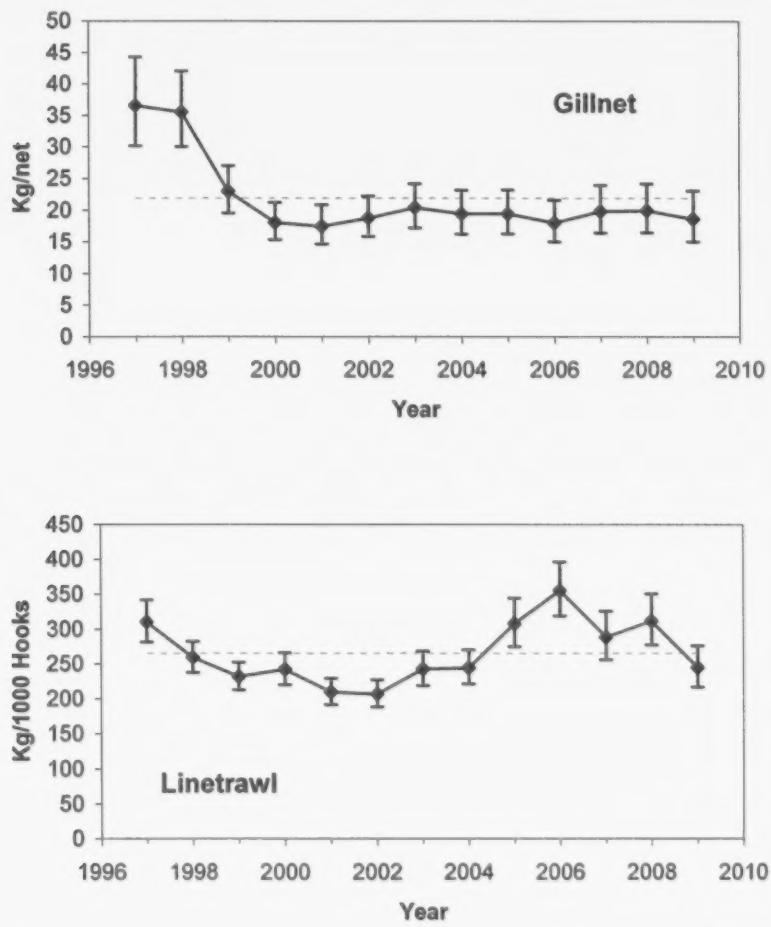
Figure 12c. Standardized catch rates for gillnets and line-trawls from science log-books for vessels <35 ft. Horizontal dashed lines are time-series average; error bars are 95 % confidence intervals of the means. Catch rates are expressed in terms of weight (kg per net or kg per 1000 hooks).
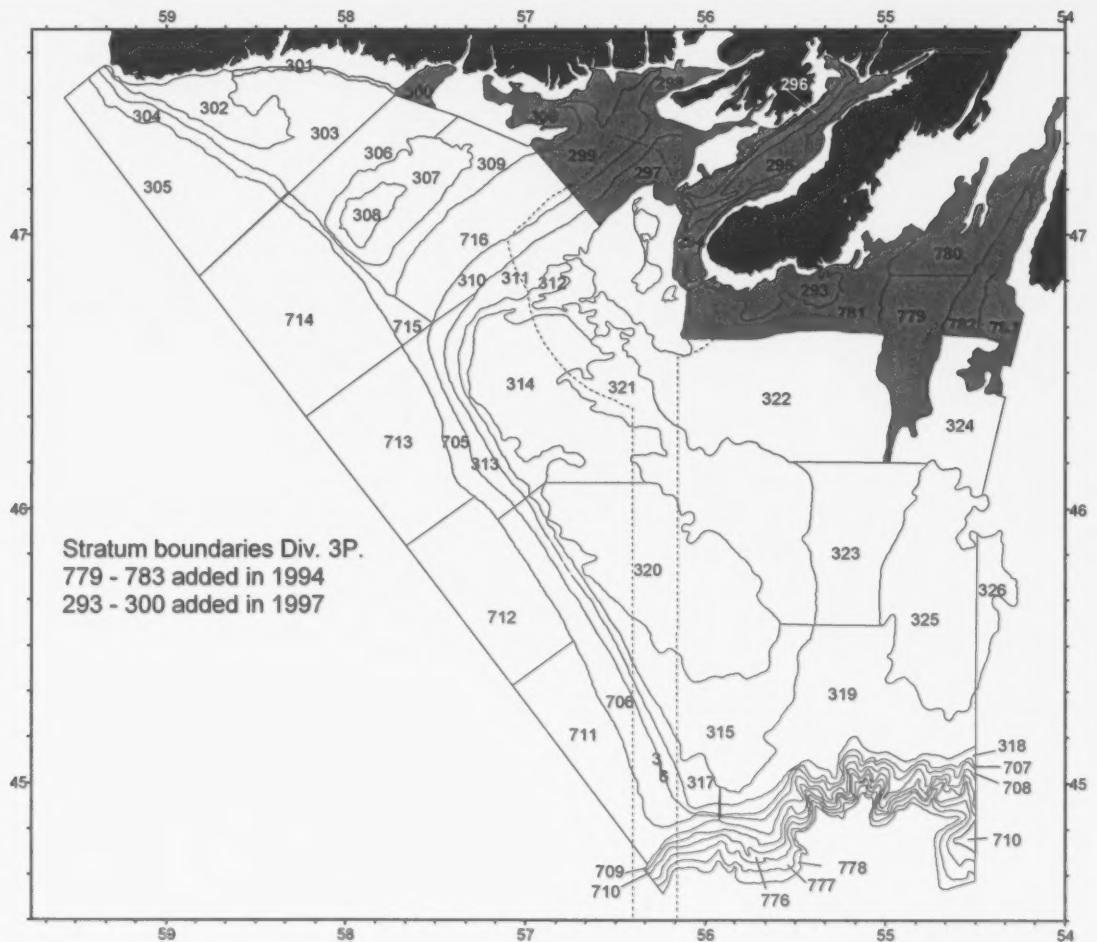
Figure 13. Stratum area boundaries and area surveyed during the DFO research vessel bottom-trawl survey of NAFO Subdivision 3Ps. Dashed line is the boundary of the French economic zone which is included in the surveyed area.
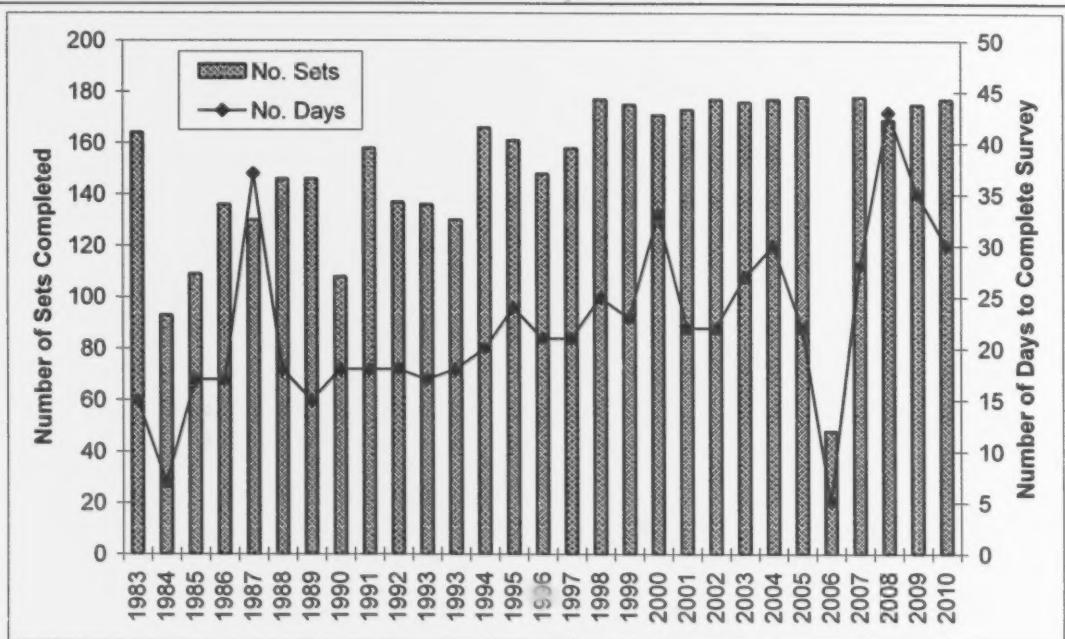
Figure 14. Number of research vessel survey sets completed during surveys of NAFO Subdivision 3Ps, and the number of days required to complete these sets over 1983-2010.
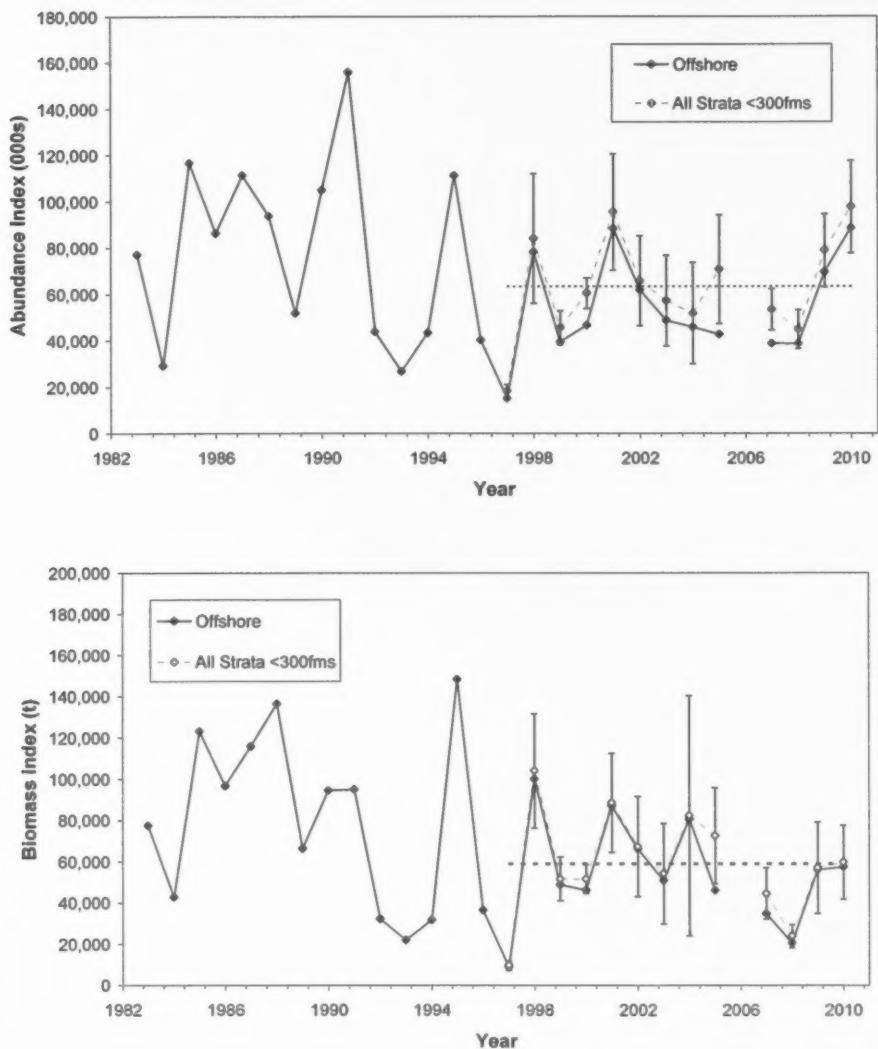
Figure 15. Abundance (upper panel) and biomass (lower panel) indices for cod in NAFO Subdivision 3Ps from DFO research vessel bottom trawl surveys of index strata during winter/spring from 1983 to 2010. The 2006 survey was not completed. Error bars show plus/minus one standard deviation. Open symbols show values for the augmented survey area that includes additional inshore strata added to the survey area since 1997.
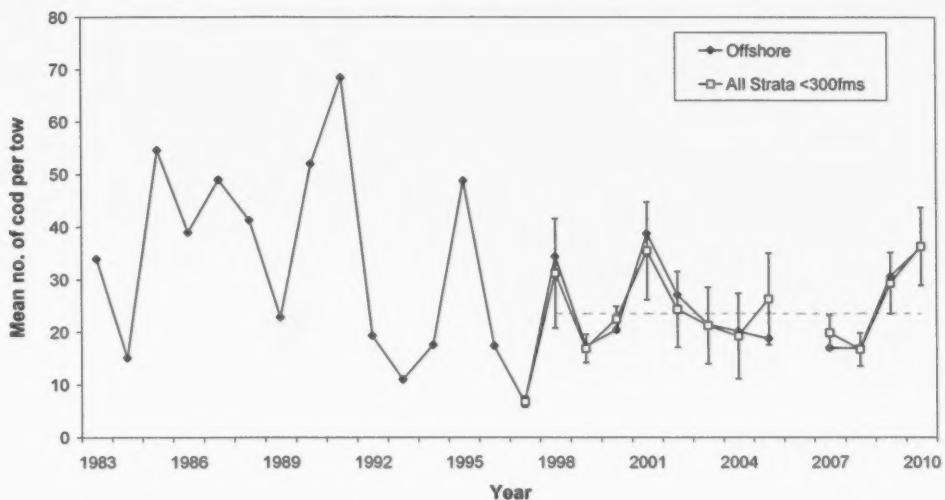
Figure 16. Age-aggregated catch rate index (mean nos. per tow) for cod in NAFO Subdivision 3Ps from DFO research vessel bottom trawl surveys of offshore (index) strata during winter/spring from 1983 to 2010. There were two surveys in 1993 and the 2006 survey was not completed. Error bars indicate one standard deviation.
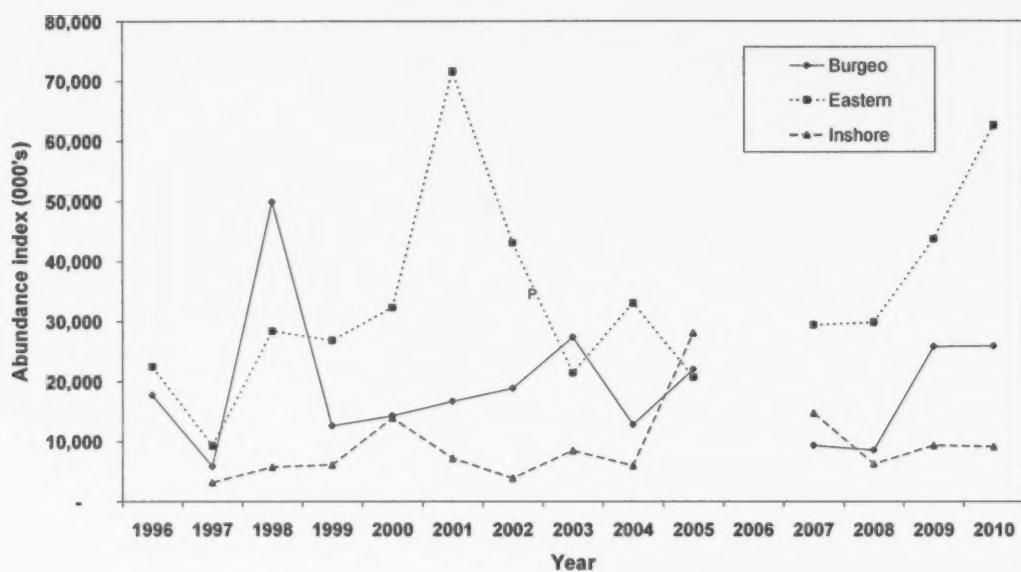
Figure 17. Total abundance index for cod in various regions of NAFO Subdivision 3Ps from DFO research vessel bottom trawl surveys during winter/spring from 1997 to 2010. The 2006 survey was not completed. The Campelen trawl was used in all surveys.
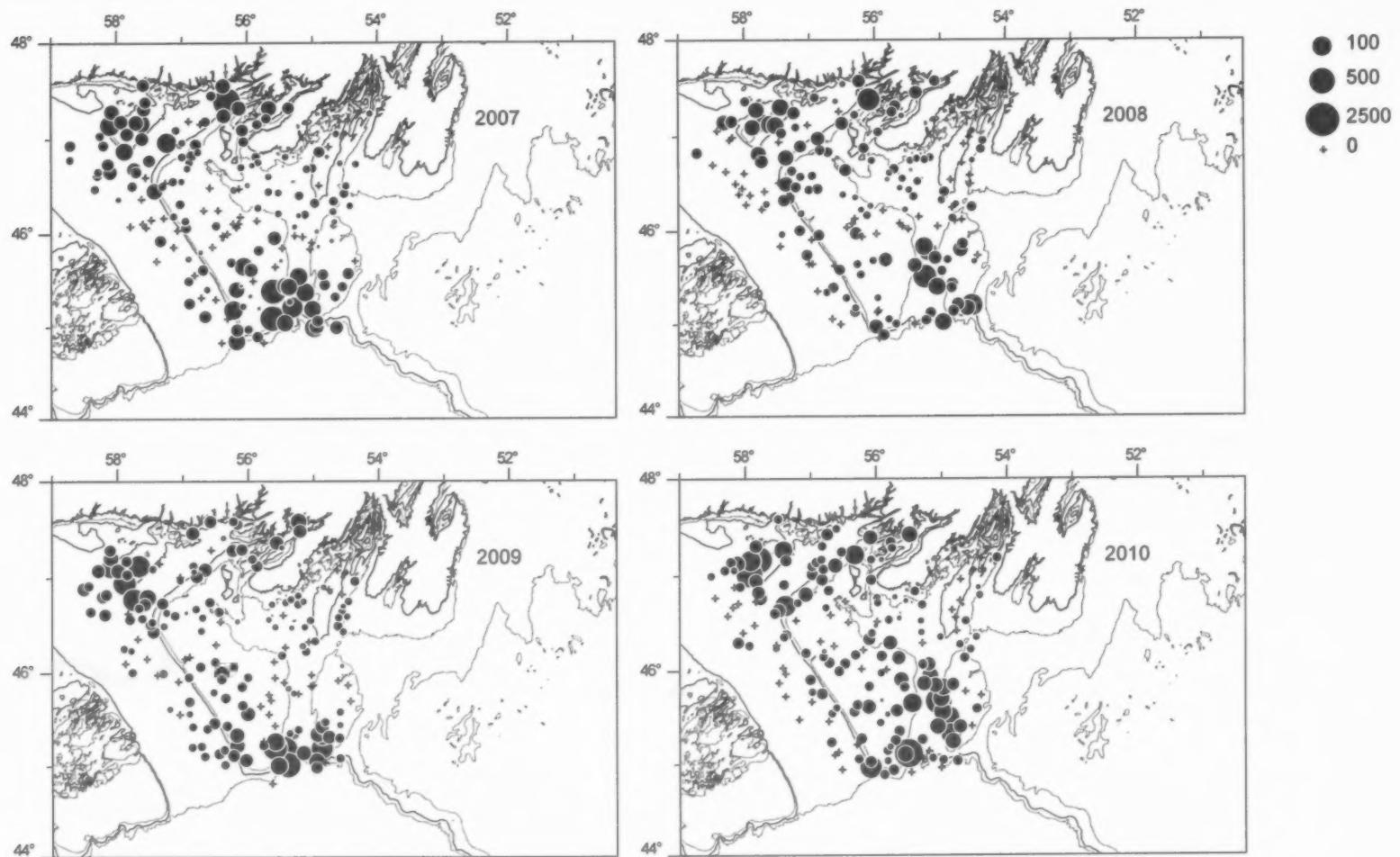
Figure 18a. Age aggregated distribution of cod catches (nos. per tow) from the April DFO research vessel surveys of NAFO Subdivision 3Ps over 2007-10. Bubble size is proportional to numbers caught.
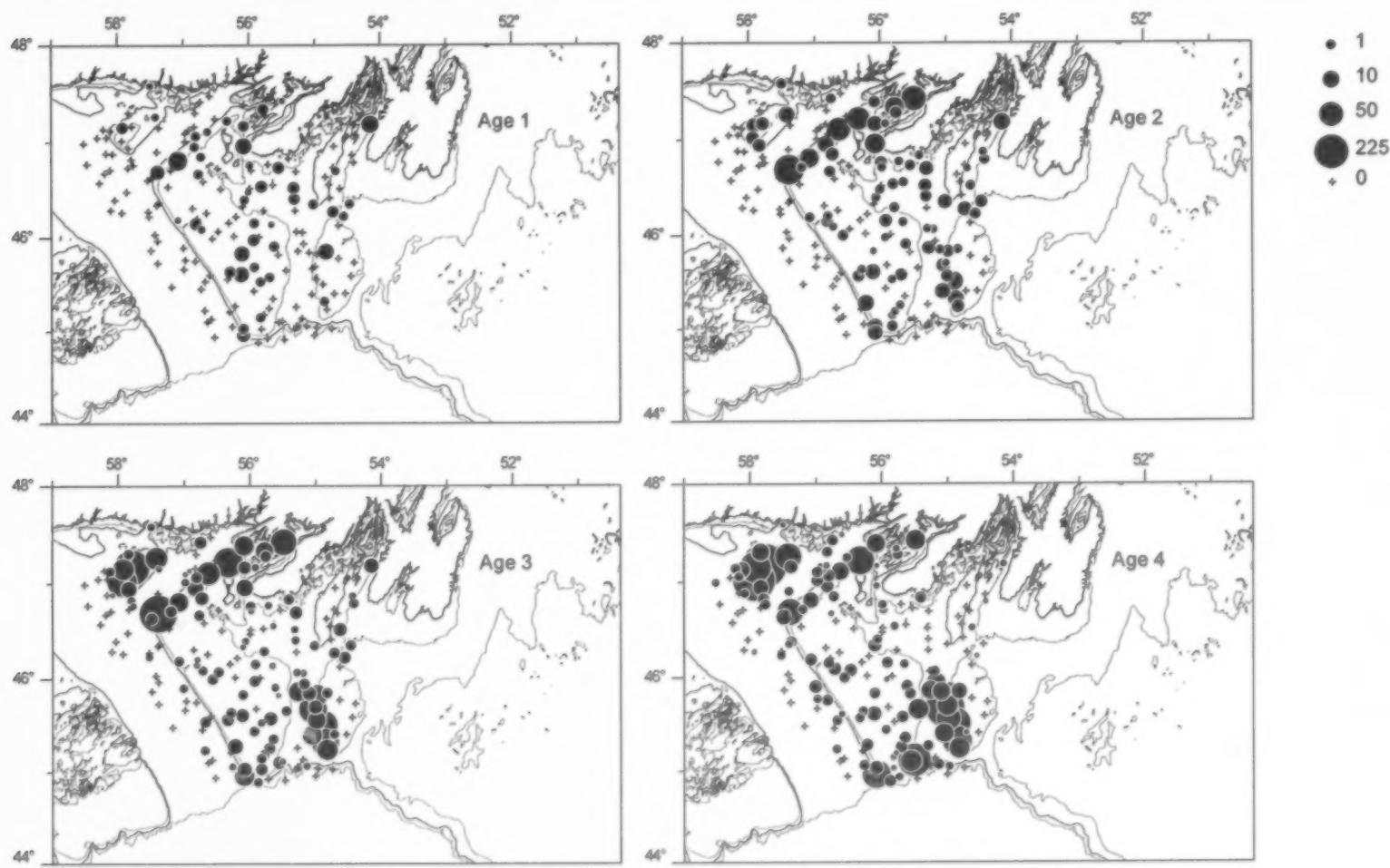
Figure 18b. Age dis-aggregated distribution of cod catches (nos. per tow, ages 1-4) from the April 2010 DFO research vessel surveys of NAFO Subdivision 3Ps. Bubble size is proportional to numbers caught.
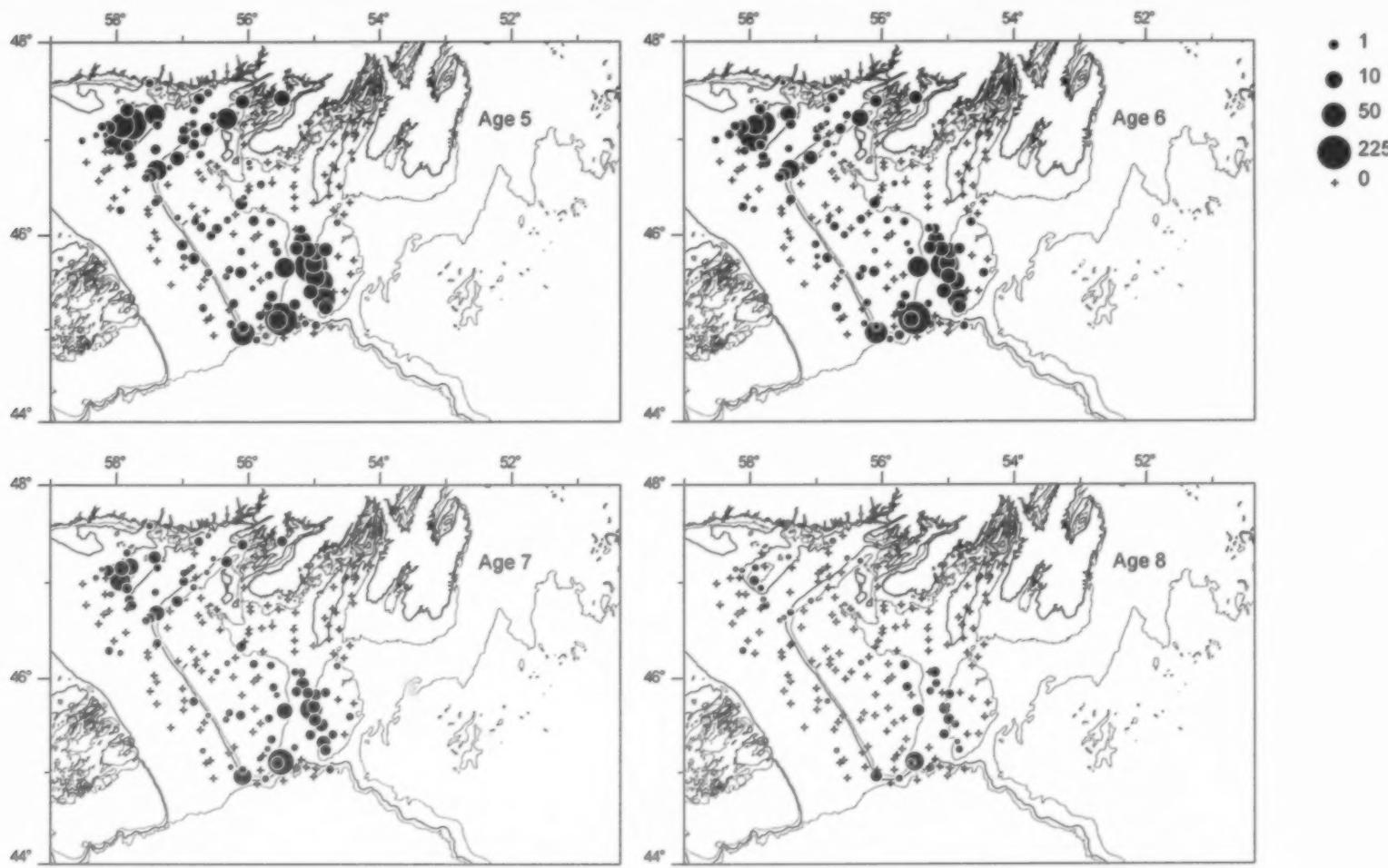
Figure 18c. Age dis-aggregated distribution of cod catches (nos. per tow, ages 5-8) from the April 2010 DFO research vessel surveys of NAFO Subdivision 3Ps. Bubble size is proportional to numbers caught.
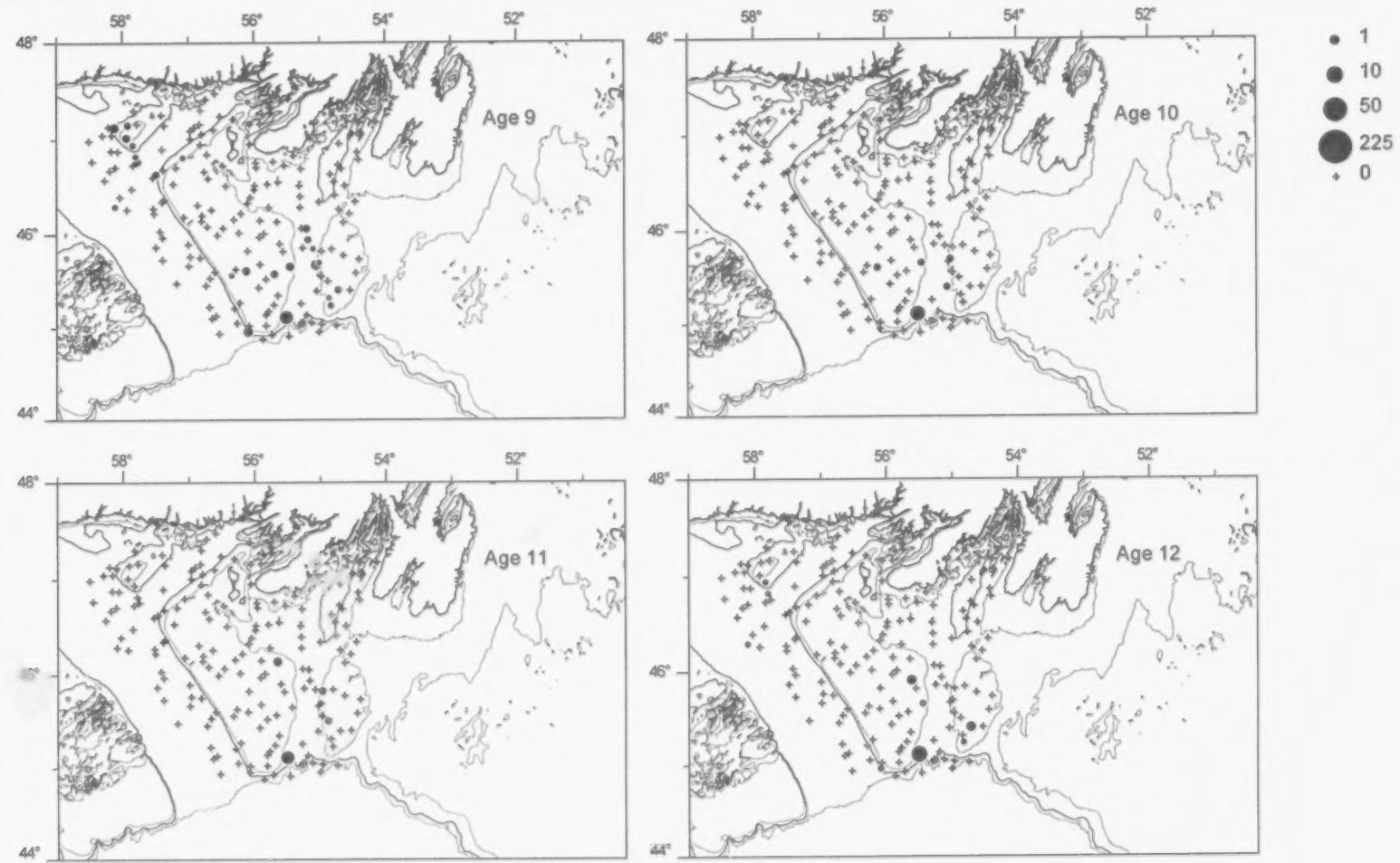
Figure 18d. Age disaggregated distribution of cod catches (nos. per tow, ages 9-12) from the DFO research vessel survey of 3Ps during April 2010. Bubble size is proportional to numbers caught.
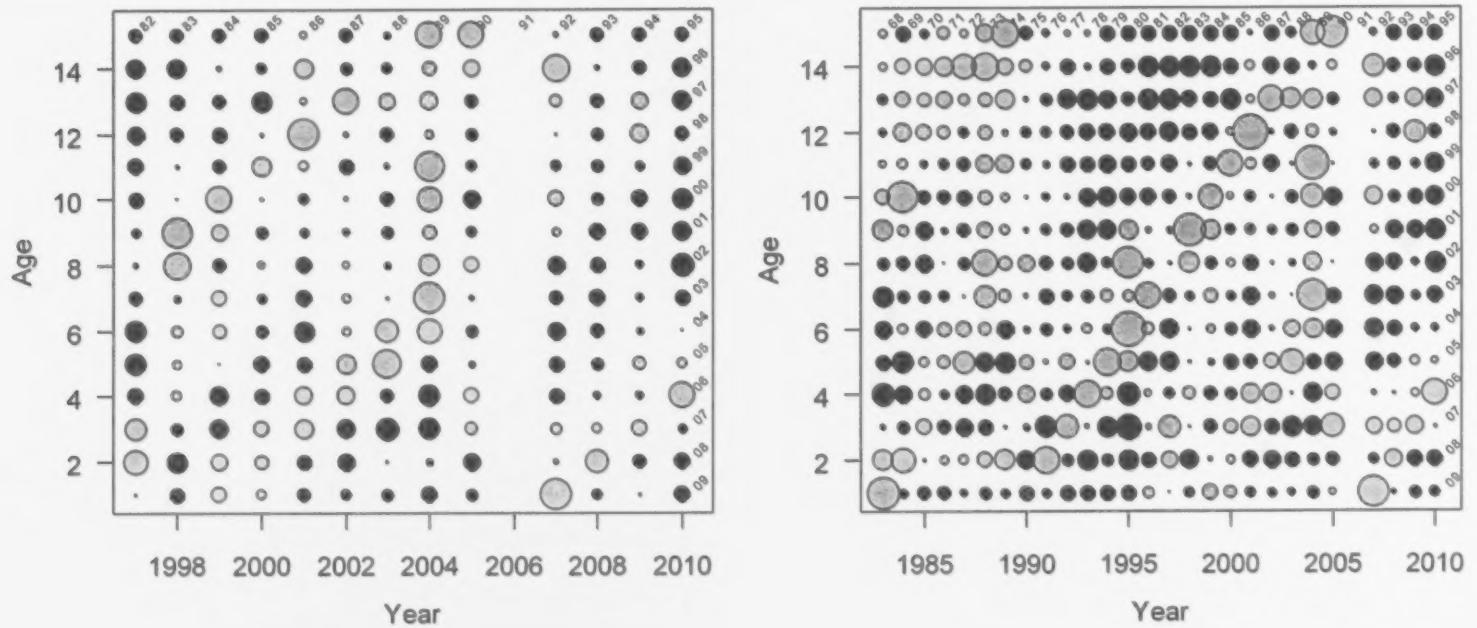
Figure 19. Standardized age-disaggregated catch rates from the spring bottom trawl survey of Subdivision 3Ps. Catch rates (mean nos per tow) were converted to proportions within each year. Values were standardized by subtracting the mean proportion and dividing by the standard deviation of the proportions computed across years. Symbol sizes are scaled and values greater than average are shown as grey circles, average values are shown as small dots, and less than average values are shown as black circles. Labels in the upper and right margins identify cohorts. Left panel includes the 1997-2010 "All Strata <300fm" data, and panel at right includes data which comprise the "Offshore" index (1983-2010).
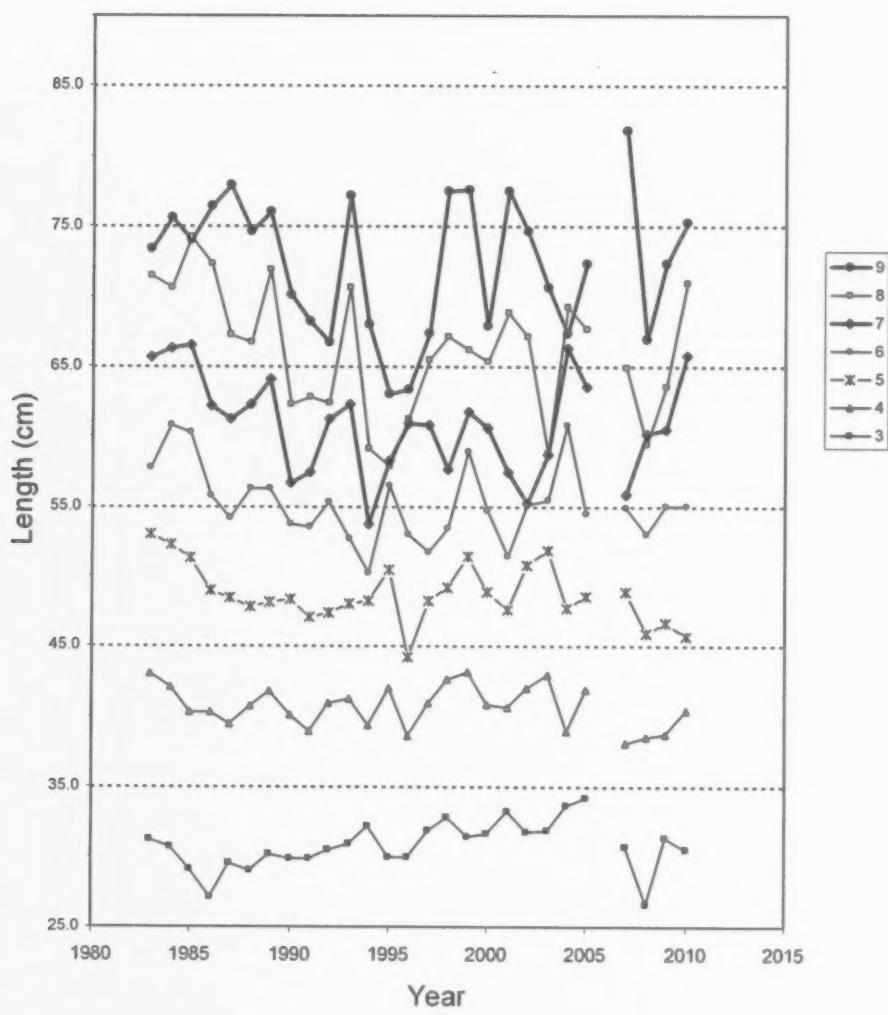
Figure 20a. Mean length at ages 3-9 of cod in Subdivision 3Ps during 1983-2010 from sampling during DFO bottom-trawl surveys in winter-spring.
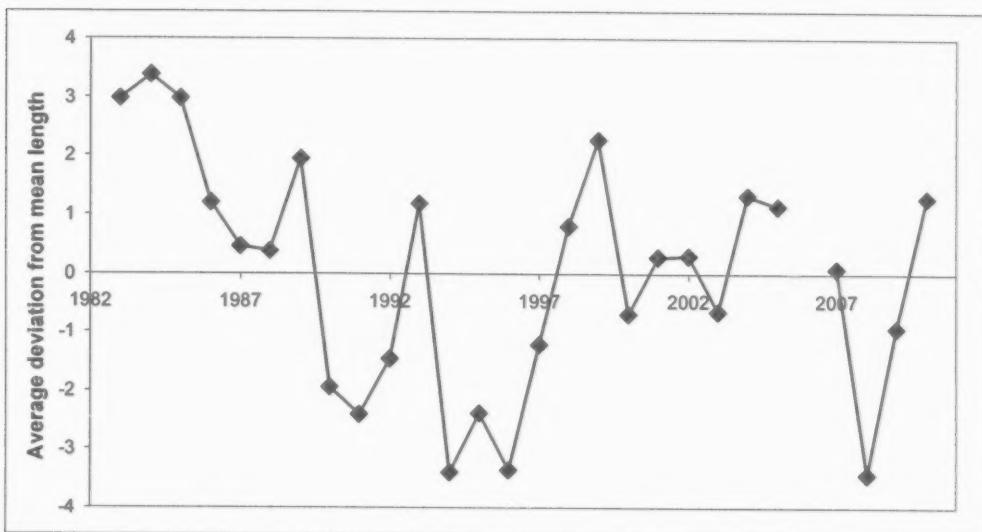
Figure 20b. Average deviation from mean length at age for ages 3-9 from DFO bottom-trawl surveys from 1983 to 2010.
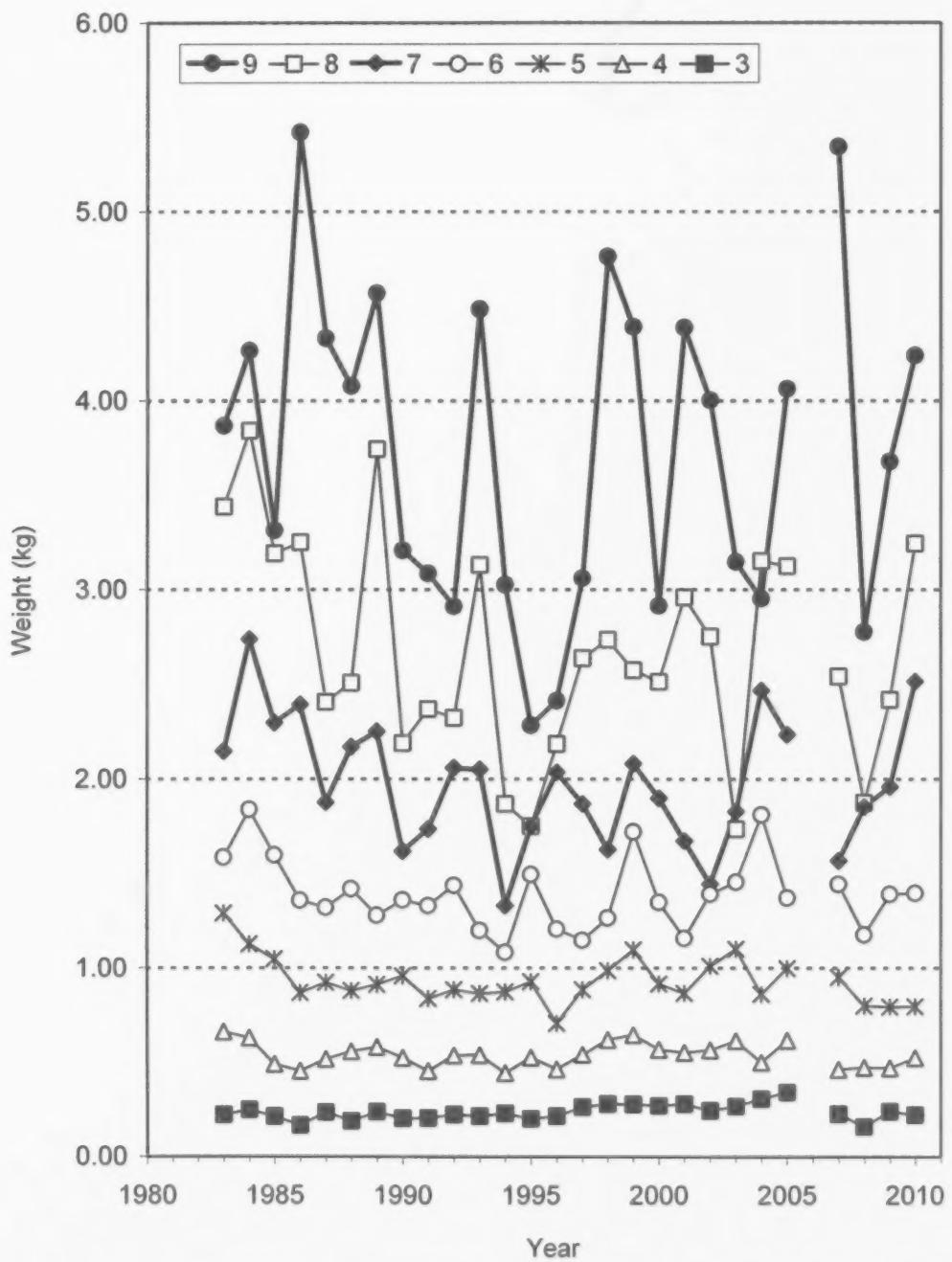
Figure 21a. Mean round weight-at-age (kg) of cod sampled during DFO bottom-trawl surveys in NAFO Subdivision 3Ps in winter-spring 1983-2010.
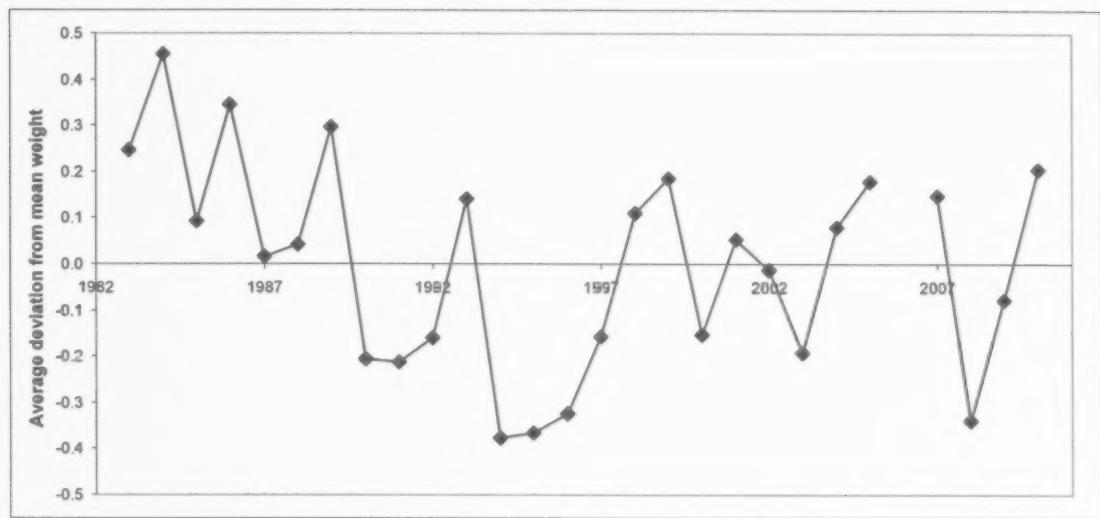
Figure 21b. Average deviation from mean weight at age for ages 3-9 from DFO bottom-trawl surveys from 1983-2010.
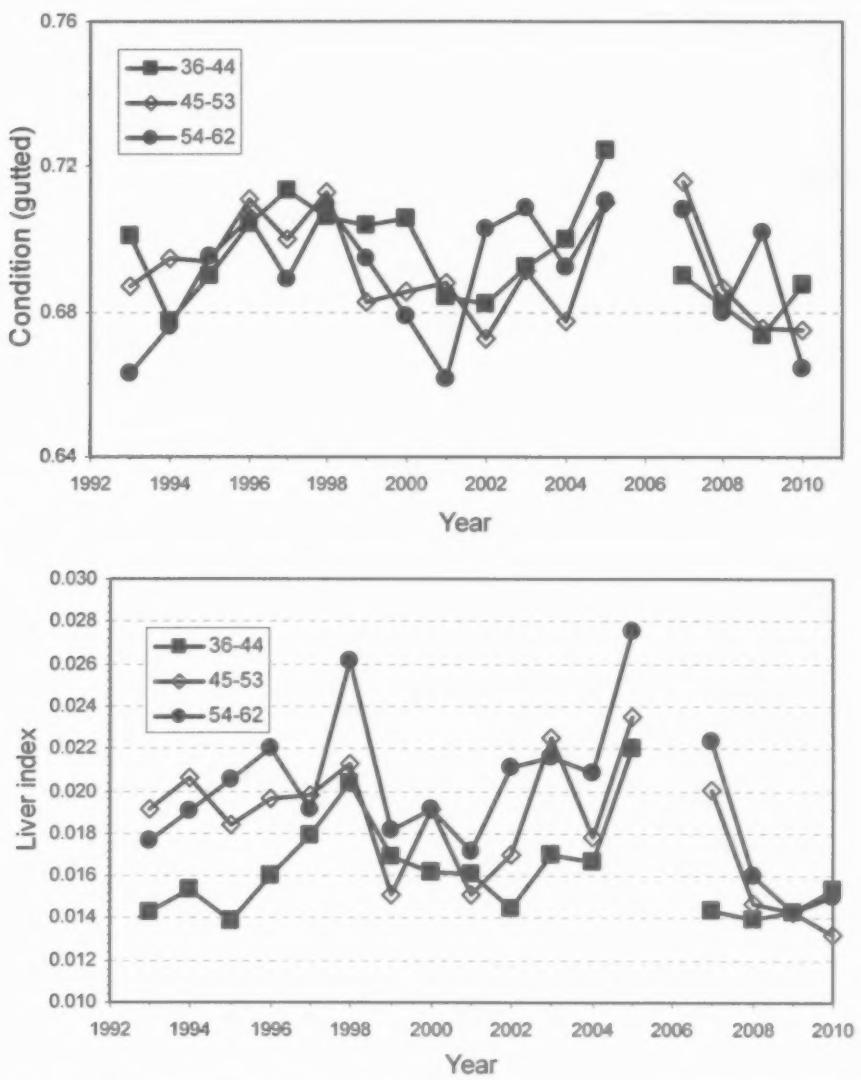
Figure 22. Fultons condition factor (top panel: gutted condition and bottom panel: liver condition) for 3 selected length groups for cod in 3Ps from RV surveys during 1993-2010.
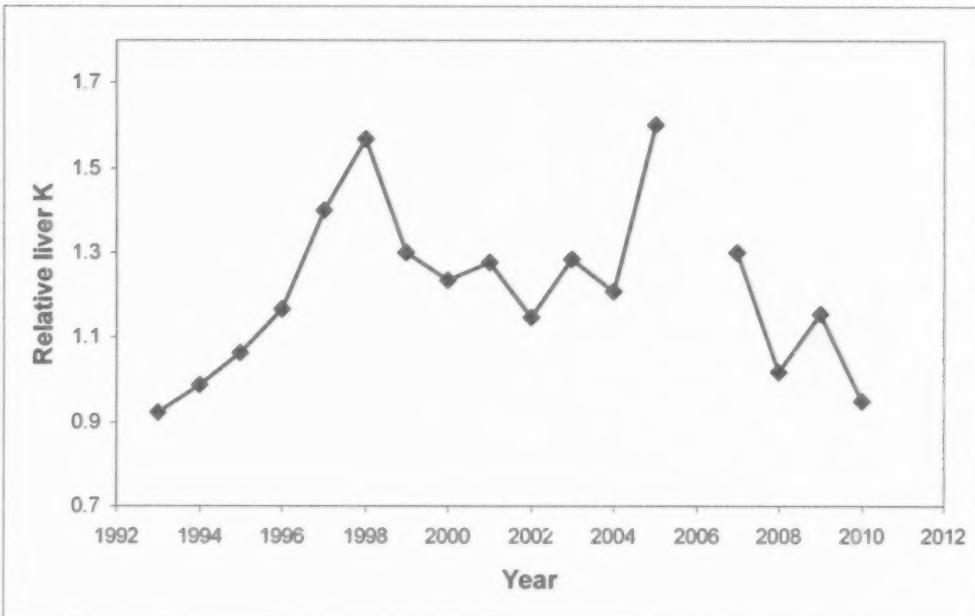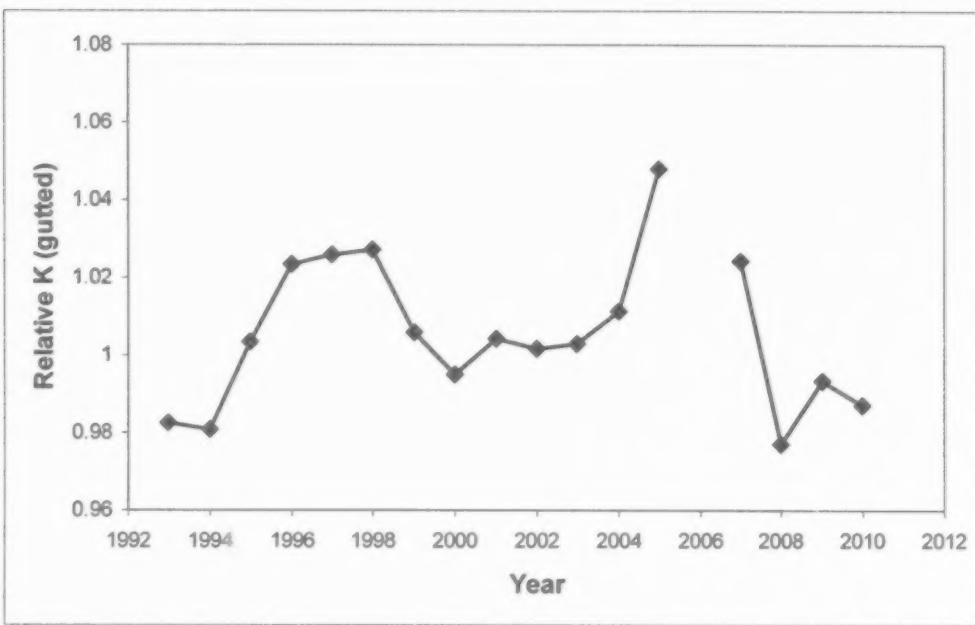
Figure 23. Relative condition indices for 3Ps cod from spring surveys over 1993-2010. Upper panel is relative gutted condition index; lower panel relative liver condition index.
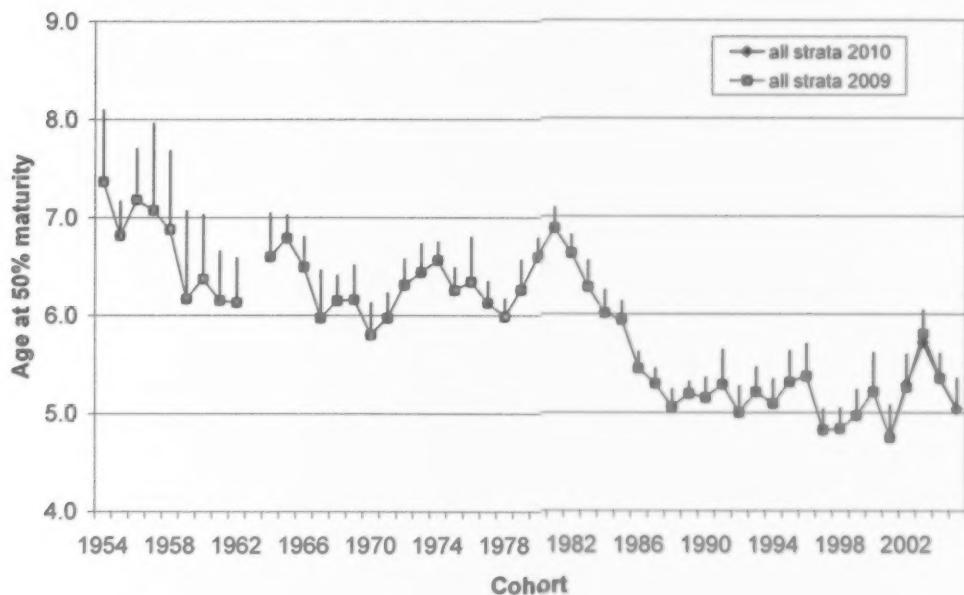
Figure 24a. Age at 50% maturity by cohort (1954-2005, excluding 1963) for female cod sampled during DFO research vessel bottom-trawl surveys of NAFO Subdivision 3Ps. Error bars are 95 % fiducial limits.
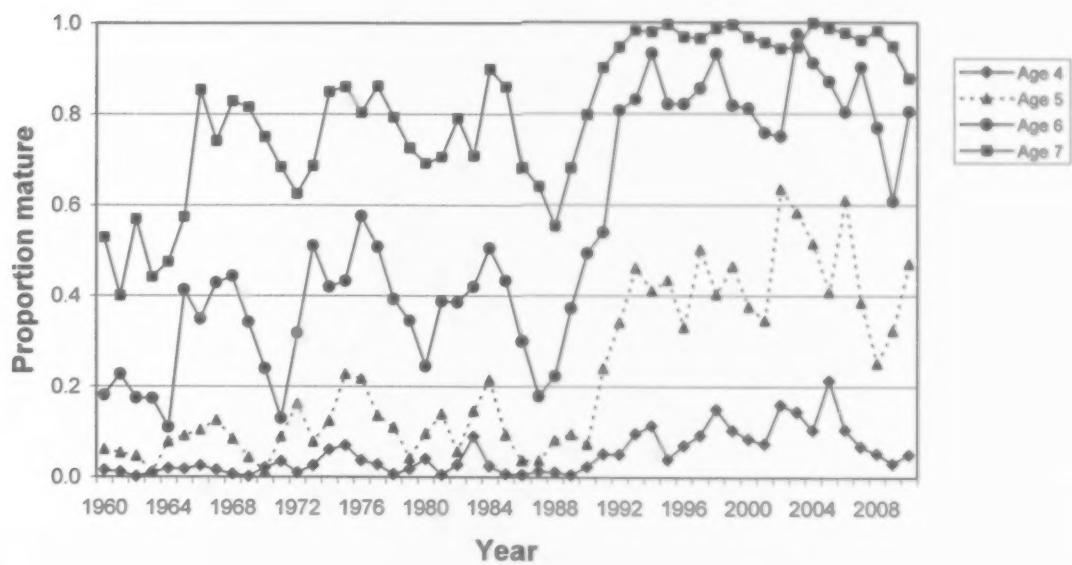
Figure 24b. Estimated proportions mature at ages 4-7 for female cod sampled during DFO research vessel bottom-trawl surveys in NAFO Subdivision 3Ps (data from all strata surveyed).
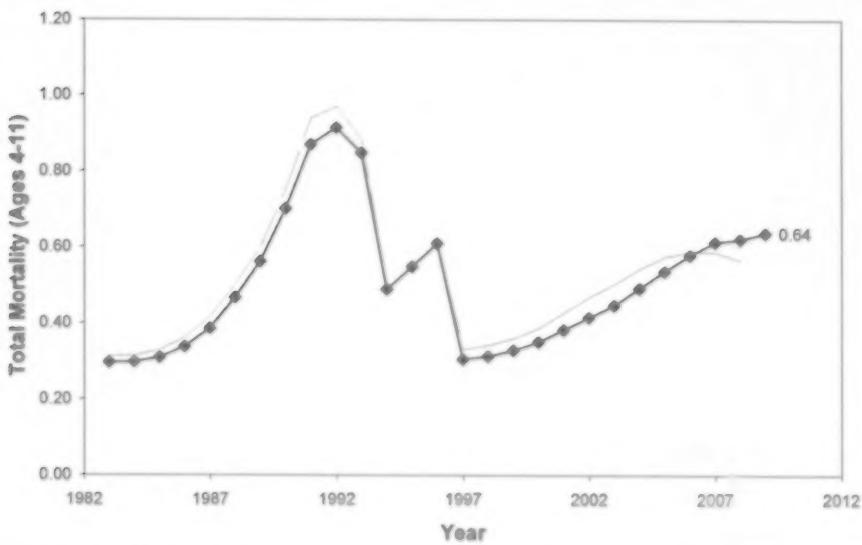
Figure 25a. Estimates of total mortality (Z) from a SURBA cohort analysis model, averaged over ages 4-11. Estimates from previous assessment (dashed line) plotted for comparison.
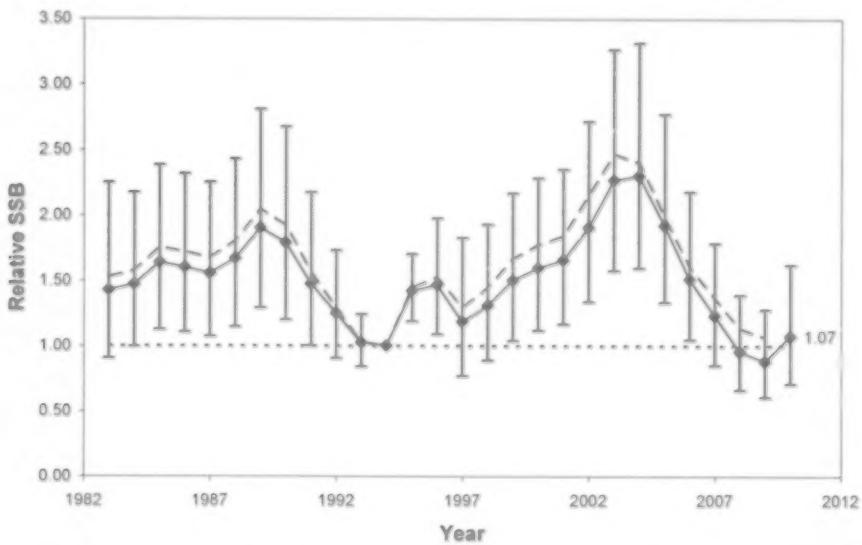
Figure 25b. Estimates of spawning stock biomass (SSB) relative to Blim from SURBA cohort analysis model (i.e., estimates are divided by 1994 SSB). Dashed line indicates estimates from the previous assessment.
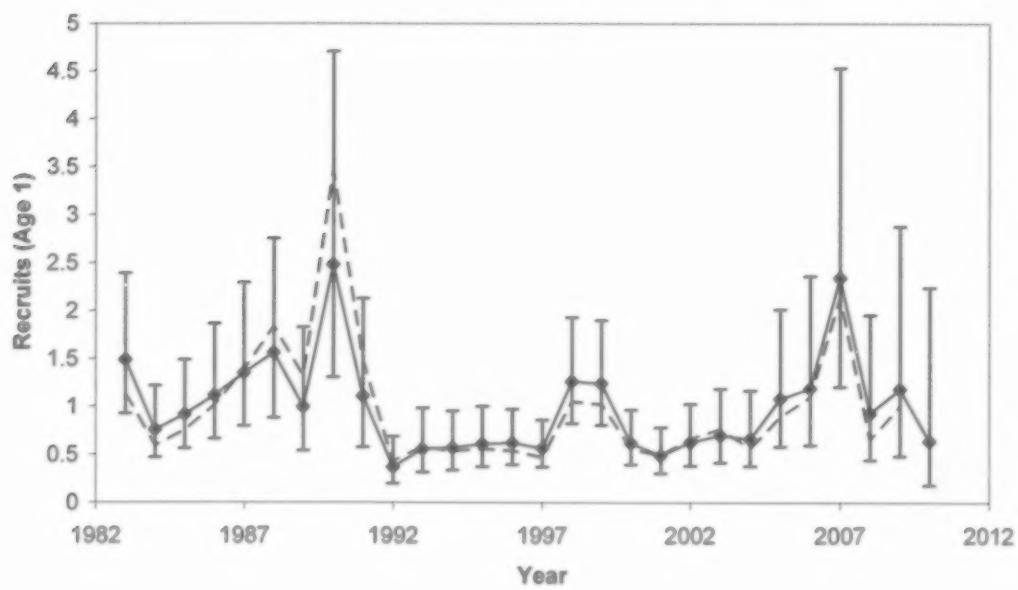
Figure 25c. Estimates of age 1 recruitment from SURBA cohort analysis model. Dashed line indicates estimates from the previous assessment; each series is scaled to its mean.
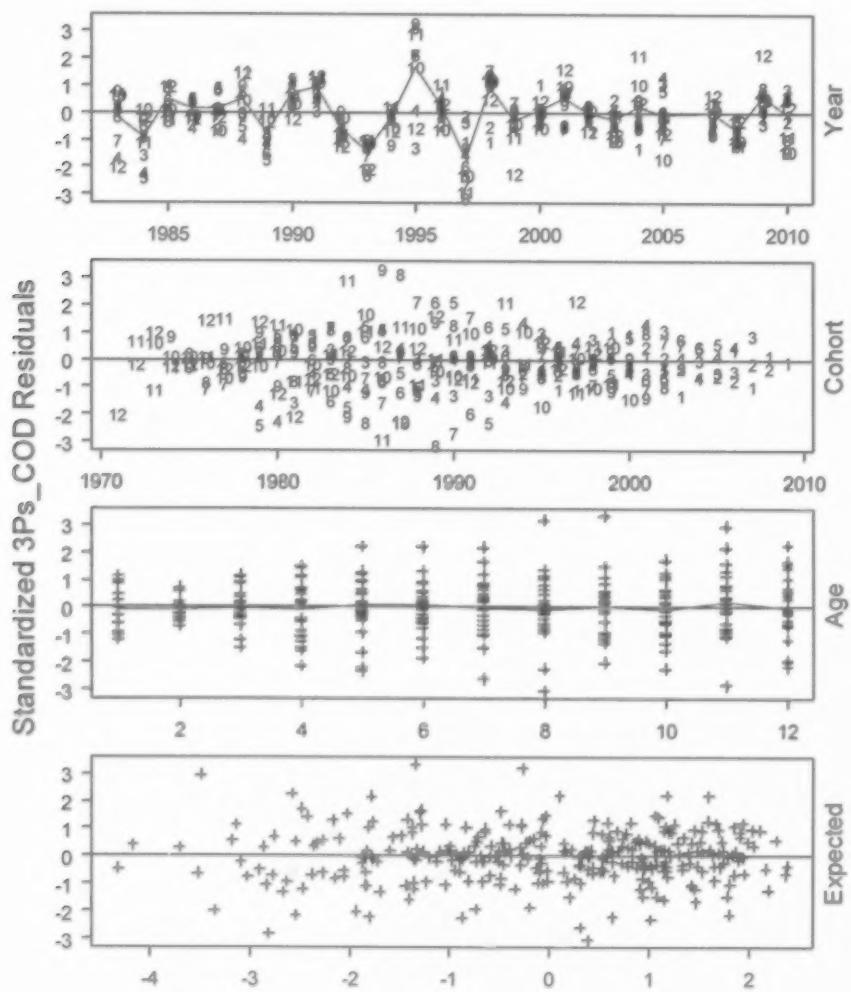
Figure 26. Standardized residuals from SURBA cohort analysis. Panels show residuals plotted year, cohort, age, and expected value, respectively.
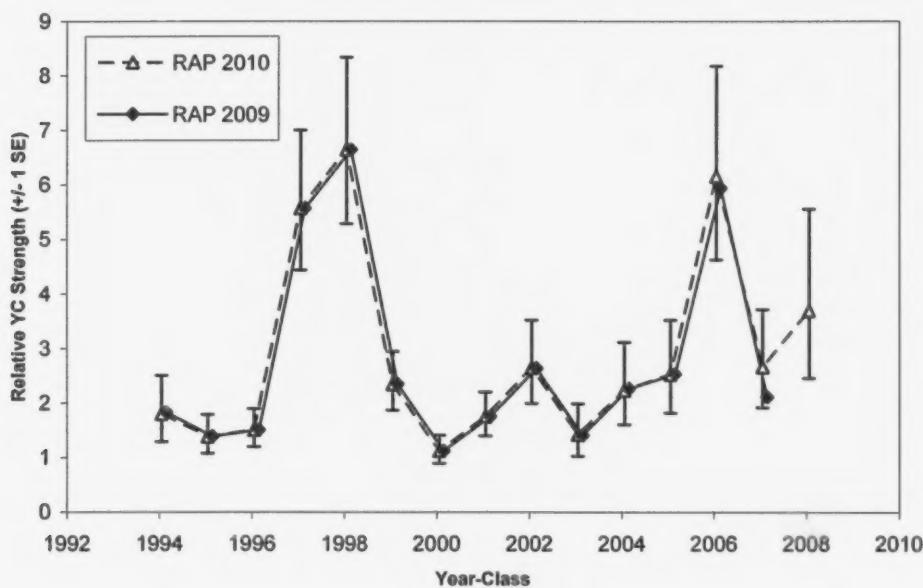
Figure 27. Standardized year-class strength estimated from catches of juvenile cod in combined inshore/offshore DFO RV survey and the GEAC survey. Solid line indicates estimates from data available during the RAP in October 2009; dashed line are estimates (and 95 % CI) produced from data available during the RAP of October 2010.

Appendix 1. SURBA estimates, output, and one-year projection results.

```
            SAS Standard SURBA for 3Ps_COD
            The NLMIXED Procedure
                Specifications

    Data Set              WORK.INPUT
    Dependent Variable           log_index
    Distribution for Dependent Variable   General
    Optimization Technique       Dual Quasi-Newton
    Integration Method           None

            Dimensions

        Observations Used       336
        Observations Not Used     0
        Total Observations      336
        Parameters          76


        Parameters

logR1972  logR1973  logR1974  logR1975  logR1976  logR1977  logR1978  logR1979  logR1980  logR1981
    1    1    1    1    1    1    1    1    1    1


logR1982  logR1983  logR1984  logR1985  logR1986  logR1987  logR1988  logR1989  logR1990  logR1991
    1    1    1    1    1    1    1    1    1    1


logR1992  logR1993  logR1994  logR1995  logR199€  logR1997  logR1998  logR1999  logR2000  logR2001
    1    1    1    1    1    1    1    1    1    1


logR2002  logR2003  logR2004  logR2005  logR2006  logR2007  logR2008  logR2009   f1983    f1984
    1    1    1    1    1    1    1    1    -1    -1


 f1985    f1986    f1987    f1988    f1989    f1990    f1991    f1992    f1993    f1994
  -1     -1     -1     -1     -1     -1     -1     -1     -1     -1


 f1995    f1996    f1997    f1998    f1999    f2000    f2001    f2002    f2003    f2004
  -1     -1     -1     -1     -1     -1     -1     -1     -1     -1


 f2005    f2006    f2007    f2008    f2009    s1     s2     s3     s4     s5
  -1     -1     -1     -1     -1     0     0     0     0     0
```

```
   s7     s8     s9     s10    s11   S_std  NegLogLike
   0      0      0      0      0     0.1    33733.0565

               Iteration History

   Iter   Calls  NegLogLike    Diff     MaxGrad    Slope

    1      16   1159.31748   32573.74   3208.732   -4.628E9
    2      24    612.300063    547.0174   728.0989  -11.0641
    3      26    468.647095    143.653    146.2523  -82.6204
    4      28    432.142405     36.50469   30.32971  -23.8062
    5      30    421.608451     10.53395   97.05217   -5.82125
    6      32    411.103789     10.50466  137.8835    -3.99057
    7      34    399.176034     11.92776   98.301    -10.7331
    8      36    387.525872     11.65016   46.38612  -13.6071
    9      37    382.211516      5.314356  89.71999   -9.44519
   10      39    353.977251     28.23427   41.38743   -8.97248
   11      40    341.231344     12.74591  108.5072   -58.6327
   12      41    329.689989     11.54135   12.46747  -45.2609
   13      43    327.54762       2.142369  33.45588   -2.90443
   14      44    326.179269      1.368351   9.964058   -2.6912
   15      46    318.502926      7.676343  35.78212   -3.38241
   16      48    312.522655      5.980272  13.04237   -5.90165
   17      49    311.407114      1.115541   8.393915   -1.92586
   18      51    306.899238      4.507876  11.43834   -1.46843
   19      53    303.740313      3.158925  12.66767   -3.88569
   20      55    302.357669      1.382644   8.134777   -1.60067
   21      57    300.125212      2.232457  37.65565   -1.22486
   22      59    298.212245      1.912967   7.834927   -1.47586
   23      61    295.934581      2.277664  11.54315   -1.36604
   24      63    294.190615      1.743966  19.54321   -1.39922
   25      65    293.394168      0.796447  13.91869   -0.81639
   26      67    292.600873      0.793295   3.666675   -0.39723
   27      69    291.962298      0.638575   6.4036     -0.61635
   28      71    291.56724       0.395058   5.127063   -0.26953
   29      73    290.965879      0.601361   4.249412   -0.54901
   30      75    290.599233      0.366646   8.697944   -0.20543
   31      77    289.955844      0.643389   4.939478   -0.38908
   32      79    289.663166      0.292678   7.595749   -0.19265
   33      81    289.131429      0.531737   4.823537   -0.21112
```

	Iter	Calls	NegLogLike	Diff	MaxGrad	Slope
34	83	288.785783	0.345646	3.369145	-0.32577	
35	85	288.43493	0.350853	3.143785	-0.17163	
36	86	288.268074	0.166855	2.51377	-0.24659	
37	88	288.152308	0.115766	2.692906	-0.12329	
38	90	287.929844	0.222464	2.090363	-0.09344	
39	92	287.82471	0.105133	2.951568	-0.041	
40	94	287.62917	0.19554	2.449263	-0.11591	
41	96	287.454602	0.174568	2.673573	-0.07156	
42	98	287.280159	0.174443	2.407699	-0.15664	
43	100	287.221514	0.058645	2.207955	-0.05443	
44	102	287.113035	0.108479	1.486384	-0.05441	
45	104	287.045969	0.067066	1.902294	-0.04287	
46	106	286.844617	0.201352	2.042927	-0.06162	
47	107	286.786454	0.058162	1.49459	-0.08446	
48	109	286.723762	0.062692	2.357155	-0.05829	
49	111	286.602637	0.121125	1.814394	-0.04964	
50	113	286.542494	0.060143	1.50448	-0.03691	
51	115	286.482167	0.060326	1.150768	-0.04386	
52	117	286.461731	0.020436	0.999337	-0.02453	
53	119	286.419585	0.042146	0.951301	-0.01947	
54	121	286.378983	0.040601	1.17563	-0.0352	
55	123	286.349567	0.029417	1.258772	-0.01229	
56	125	286.33293	0.016637	0.74553	-0.01724	
57	127	286.313184	0.019746	0.521303	-0.00669	
58	129	286.303482	0.009702	0.587655	-0.01043	
59	131	286.292445	0.011037	0.777202	-0.0047	
60	133	286.28174	0.010705	0.36005	-0.00825	
61	135	286.276906	0.004834	1.080273	-0.00267	
62	137	286.269728	0.007179	0.456786	-0.00439	
63	139	286.265425	0.004303	0.709967	-0.00233	
64	141	286.262843	0.002582	0.213224	-0.00264	
65	143	286.260562	0.00228	0.249298	-0.00049	
66	145	286.25849	0.002072	0.321671	-0.00191	
67	147	286.257104	0.001386	0.126677	-0.0006	
68	149	286.256772	0.000332	0.147546	-0.0004	
69	151	286.256236	0.000536	0.085842	-0.00021	
70	153	286.255764	0.000472	0.121626	-0.00041	
71	155	286.255248	0.000515	0.096713	-0.00016	

```
       Iter   Calls  NegLogLike    Diff    MaxGrad   Slope

        72    157    286.25513   0.000119    0.091   -0.00009
        73    159    286.254826  0.000304  0.083749  -0.00012
        74    161    286.254667  0.000159  0.199384  -0.00007
        75    163    286.254355  0.000311  0.089283  -0.00016
        76    165    286.254175   0.00018  0.075339  -0.00005
        77    167    286.254082  0.000093  0.065297   -0.0001
        78    169    286.253887  0.000194  0.067227  -0.00004
        79    170    286.253835  0.000053  0.044178  -0.00008
        80    172    286.253787  0.000048  0.045256  -0.00004
        81    174    286.253637   0.00015  0.066048  -0.00004
        82    177    286.253399  0.000238  0.064305  -0.00003
        83    178    286.253369   0.00003  0.041569  -0.00004
        84    180    286.253321  0.000048  0.039756  -0.00004
        85    182    286.253226  0.000095  0.024401  -0.00005
        86    185     286.25298  0.000245  0.023554  -9.78E-6
        87    187    286.252962  0.000018  0.029204  -0.00001
        88    189    286.252835  0.000127  0.019335  -0.00002
        89    190    286.252817  0.000018  0.028236  -0.00003
        90    192    286.252787   0.00003  0.044217  -0.00002
        91    194    286.252636  0.000151  0.023487  -0.00004
        92    197    286.252523  0.000113  0.071264  -3.75E-6
        93    198    286.252501  0.000021  0.021002  -0.00004
        94    200    286.252493   8.41E-6  0.027731  -5.33E-6
        95    203    286.252391  0.000102  0.020767  -0.00001
        96    205    286.252381  9.236E-6  0.014885  -3.79E-6
        97    207    286.252299  0.000083  0.012125  -0.00001
        98    208    286.252293  5.777E-6  0.013382  -0.00001
        99    210    286.252287   5.86E-6  0.015886  -1.83E-6
       NOTE: GCONV convergence criterion satisfied.

          Fit Statistics

       -2 Log Likelihood        572.5
       AIC (smaller is better)     724.5
       AICC (smaller is better)     769.7
       BIC (smaller is better)     1014.6
```

Appendix 1 (Cont'd.)

Parameter Estimates

```
        Standard
Parameter  Estimate   Error  DF  t Value  Pr > |t|  Alpha   Lower     Upper    Gradient
logR1972   -1.5283   0.4422  336   -3.46   0.0006    0.05  -2.3983  -0.6584    0.005398
logR1973   -0.7339   0.3699  336   -1.98   0.0481    0.05  -1.4616  -0.00631  -0.00401
logR1974   -0.05351  0.3328  336   -0.16   0.8723    0.05  -0.7081   0.6011    0.003392
logR1975   -0.2272   0.3151  336   -0.72   0.4713    0.05  -0.8470   0.3926   -0.01198
logR1976   -0.07668  0.2967  336   -0.26   0.7962    0.05  -0.6602   0.5069   -0.0068
logR1977    0.5458   0.2770  336    1.97   0.0496    0.05   0.000973 1.0907    0.002618
logR1978    1.1972   0.2564  336    4.67   <.0001    0.05   0.6929   1.7015   -0.00638
logR1979    1.1183   0.2387  336    4.69   <.0001    0.05   0.6488   1.5878   -0.00242
logR1980    1.8588   0.2255  336    8.24   <.0001    0.05   1.4152   2.3025    0.002367
logR1981    1.9783   0.2302  336    8.59   <.0001    0.05   1.5255   2.4312    0.001403
logR1982    2.3724   0.2409  336    9.85   <.0001    0.05   1.8986   2.8461   -0.00175
logR1983    1.6966   0.2425  336    7.00   <.0001    0.05   1.2196   2.1735   -0.00289
logR1984    1.8849   0.2471  336    7.63   <.0001    0.05   1.3990   2.3709    0.002724
logR1985    2.0833   0.2616  336    7.96   <.0001    0.05   1.5687   2.5979    0.003006
logR1986    2.2760   0.2682  336    8.49   <.0001    0.05   1.7484   2.8036   -0.0022
logR1987    2.4187   0.2886  336    8.38   <.0001    0.05   1.8510   2.9863    0.007827
logR1988    1.9704   0.3097  336    6.36   <.0001    0.05   1.3611   2.5797    0.003972
logR1989    2.8833   0.3256  336    8.86   <.0001    0.05   2.2428   3.5238    0.001122
logR1990    2.0775   0.3317  336    6.26   <.0001    0.05   1.4250   2.7300    0.001296
logR1991    0.9783   0.3168  336    3.09   0.0022    0.05   0.3552   1.6015   -0.00226
logR1992    1.3901   0.2890  336    4.81   <.0001    0.05   0.8217   1.9586   -0.00123
logR1993    1.4097   0.2637  336    5.35   <.0001    0.05   0.8910   1.9285    0.001932
logR1994    1.4788   0.2526  336    5.85   <.0001    0.05   0.9819   1.9758   -0.00594
logR1995    1.4980   0.2286  336    6.55   <.0001    0.05   1.0483   1.9476    0.002575
logR1996    1.4000   0.2159  336    6.48   <.0001    0.05   0.9752   1.8248    0.002335
logR1997    2.2087   0.2160  336   10.22   <.0001    0.05   1.7837   2.6336   -0.00272
logR1998    2.1892   0.2181  336   10.04   <.0001    0.05   1.7602   2.6183    0.000442
logR1999    1.4928   0.2273  336    6.57   <.0001    0.05   1.0457   1.9399    0.005982
logR2000    1.2579   0.2383  336    5.28   <.0001    0.05   0.7892   1.7265   -0.00556
logR2001    1.5091   0.2512  336    6.01   <.0001    0.05   1.0150   2.0031    0.006249
logR2002    1.6181   0.2672  336    6.06   <.0001    0.05   1.0926   2.1436   -0.00315
logR2003    1.5643   0.2877  336    5.44   <.0001    0.05   0.9984   2.1302    0.006072
logR2004    2.0559   0.3140  336    6.55   <.0001    0.05   1.4384   2.6735   -0.00484
logR2005    2.1473   0.3493  336    6.15   <.0001    0.05   1.4601   2.8344   -0.00295
logR2006    2.8254   0.3359  336    8.41   <.0001    0.05   2.1647   3.4861   -0.00328
logR2007    1.9022   0.3774  336    5.04   <.0001    0.05   1.1599   2.6445   -0.00369
logR2008    2.1410   0.4531  336    4.73   <.0001    0.05   1.2497   3.0322   -0.00335
```

Parameter	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper	Gradient
logR2009	1.5321	0.6349	336	2.41	0.0163	0.05	0.2833	2.7809	-0.00379
f1983	-1.3942	0.2766	336	-5.04	<.0001	0.05	-1.9384	-0.8500	0.005988
f1984	-1.3905	0.2546	336	-5.46	<.0001	0.05	-1.8913	-0.8896	0.003983
f1985	-1.3511	0.2384	336	-5.67	<.0001	0.05	-1.8200	-0.8821	0.00214
f1986	-1.2645	0.2305	336	-5.49	<.0001	0.05	-1.7178	-0.8112	-0.00035
f1987	-1.1292	0.2260	336	-5.00	<.0001	0.05	-1.5738	-0.6846	-0.00266
f1988	-0.9378	0.2218	336	-4.23	<.0001	0.05	-1.3740	-0.5015	-0.00163
f1989	-0.7532	0.2148	336	-3.51	0.0005	0.05	-1.1757	-0.3308	-0.00155
f1990	-0.5316	0.2110	336	-2.52	0.0122	0.05	-0.9467	-0.1166	-0.00148
f1991	-0.3152	0.2133	336	-1.48	0.1405	0.05	-0.7349	0.1045	-0.00186
f1992	-0.2657	0.2173	336	-1.22	0.2223	0.05	-0.6931	0.1617	-0.00112
f1993	-0.3411	0.2282	336	-1.49	0.1359	0.05	-0.7899	0.1077	-0.00136
f1994	-0.8919	0.2316	336	-3.85	0.0001	0.05	-1.3475	-0.4363	0.001517
f1995	-0.7771	0.2264	336	-3.43	0.0007	0.05	-1.2225	-0.3317	0.001766
f1996	-0.6710	0.2426	336	-2.77	0.0060	0.05	-1.1483	-0.1937	0.001669
f1997	-1.3662	0.2603	336	-5.25	<.0001	0.05	-1.8783	-0.8540	-0.00406
f1998	-1.3391	0.2416	336	-5.54	<.0001	0.05	-1.8143	-0.8638	-0.00332
f1999	-1.2898	0.2311	336	-5.58	<.0001	0.05	-1.7445	-0.8352	-0.00229
f2000	-1.2253	0.2254	336	-5.44	<.0001	0.05	-1.6686	-0.7820	-0.00113
f2001	-1.1393	0.2222	336	-5.13	<.0001	0.05	-1.5763	-0.7023	0.000029
f2002	-1.0564	0.2193	336	-4.82	<.0001	0.05	-1.4877	-0.6251	0.000964
f2003	-0.9820	0.2183	336	-4.50	<.0001	0.05	-1.4114	-0.5527	0.000948
f2004	-0.8867	0.2204	336	-4.02	<.0001	0.05	-1.3202	-0.4531	0.001292
f2005	-0.7995	0.2202	336	-3.63	0.0003	0.05	-1.2326	-0.3664	0.001398
f2006	-0.7230	0.2161	336	-3.35	0.0009	0.05	-1.1481	-0.2980	0.000801
f2007	-0.6652	0.2138	336	-3.11	0.0020	0.05	-1.0858	-0.2445	-0.00125
f2008	-0.6515	0.2159	336	-3.02	0.0027	0.05	-1.0762	-0.2269	-0.00299
f2009	-0.6268	0.2304	336	-2.72	0.0069	0.05	-1.0799	-0.1736	-0.00432
s1	-1.1955	0.5780	336	-2.07	0.0394	0.05	-2.3324	-0.05853	-0.0009
s2	-1.1793	0.4773	336	-2.47	0.0140	0.05	-2.1183	-0.2404	0.001769
s3	-1.0913	0.4025	336	-2.71	0.0070	0.05	-1.8831	-0.2995	-0.00425
s4	-0.8775	0.3514	336	-2.50	0.0130	0.05	-1.5686	-0.1863	0.005433
s5	-0.4673	0.2971	336	-1.57	0.1167	0.05	-1.0517	0.1171	0.001264
s7	0.3214	0.2807	336	1.15	0.2530	0.05	-0.2307	0.8735	0.007562
s8	0.4810	0.2811	336	1.71	0.0880	0.05	-0.07201	1.0341	0.001276
s9	0.5002	0.2614	336	1.91	0.0566	0.05	-0.01408	1.0144	-0.01589
s10	0.3563	0.2548	336	1.40	0.1629	0.05	-0.1448	0.8574	0.005314
s11	0.3452	0.2634	336	1.31	0.1908	0.05	-0.1728	0.8633	-0.00179
S_std	0.6344	0.02603	336	24.37	<.0001	0.05	0.5832	0.6856	-0.00359

Appendix 1 (Cont'd.)

Spawning stock biomass (ssb) and Age 3+ biomass (bms) trends relative to 1994 level
(1994 SSB is LRP for this stock; B_Recovery)

Obs	year	rssb_Brec	rssb_tvalue	rssb_Brec_L	rssb_Brec_U	rbms_Brec	rbms_tvalue	rbms_Brec_L	rbms_Brec_U
1	1983	1.42661	1.53229	0.90411	2.25109	1.41352	1.71772	0.95101	2.10099
2	1984	1.47147	1.94145	0.99492	2.17628	1.67145	2.83466	1.17026	2.38728
3	1985	1.63733	2.58343	1.12484	2.38331	2.04238	4.04141	1.44273	2.89126
4	1986	1.60064	2.50169	1.10576	2.31701	2.07724	4.15574	1.46963	2.93604
5	1987	1.55455	2.33882	1.07265	2.25295	2.11420	4.20274	1.48924	3.00142
6	1988	1.66879	2.67949	1.14587	2.43034	2.19671	4.36116	1.54035	3.13274
7	1989	1.90500	3.25921	1.29113	2.81075	2.18358	4.37799	1.53737	3.10142
8	1990	1.79053	2.85350	1.19837	2.67530	2.07502	4.24851	1.47993	2.90939
9	1991	1.47632	1.97727	1.00202	2.17515	1.70326	3.32963	1.24350	2.33299
10	1992	1.25121	1.35406	0.90352	1.73268	1.38885	2.76272	1.09922	1.75480
11	1993	1.02247	0.22327	0.84066	1.24360	1.07483	1.02687	0.93607	1.23416
12	1994	1.00000	.	0.00000	0.00000	1.00000	.	0.00000	0.00000
13	1995	1.42268	3.85378	1.18839	1.70316	1.19743	2.89411	1.05941	1.35343
14	1996	1.46669	2.52179	1.08791	1.97737	1.19935	1.53459	0.95006	1.51404
15	1997	1.18419	0.76658	0.76740	1.82737	1.00011	0.00063	0.69904	1.43087
16	1998	1.30960	1.36683	0.88830	1.93071	1.12288	0.69405	0.80850	1.55950
17	1999	1.50049	2.16624	1.03802	2.16901	1.30432	1.62171	0.94499	1.80029
18	2000	1.59594	2.56646	1.11536	2.28360	1.47831	2.39863	1.07287	2.03698
19	2001	1.65528	2.82747	1.16575	2.35039	1.71755	3.29708	1.24383	2.37168
20	2002	1.90634	3.58067	1.33743	2.71724	1.75265	3.28327	1.25226	2.45299
21	2003	2.26858	4.42752	1.57652	3.26444	1.79747	3.37210	1.27676	2.53053
22	2004	2.30074	4.48257	1.59614	3.31637	1.72902	3.13480	1.22626	2.43791
23	2005	1.92282	3.50887	1.33280	2.77403	1.49984	2.32612	1.06457	2.11308
24	2006	1.50865	2.19593	1.04379	2.18053	1.25383	1.29467	0.88916	1.76806
25	2007	1.23192	1.10314	0.84930	1.78690	1.16910	0.88966	0.82762	1.65149
26	2008	0.95577	-0.23857	0.65819	1.38789	1.11410	0.60456	0.78388	1.58342
27	2009	0.87892	-0.67840	0.60455	1.27782	1.34028	1.54797	0.92377	1.94458
28	2010	1.07169	0.32880	0.70824	1.62164	1.41117	1.68680	0.94438	2.10868

Projection of SURBA estimates at various multiples of status quo total mortality (Z)
ssb and biomass trends relative to 1994

Obs	year	rssb_zmult	rssb_Brec	rssb_Brec_L	rssb_Brec_U	rbms_tvalue	rbms_Brec	rbms_Brec_L	rbms_Brec_U	tvalue
2	2011	0.8	1.47487	0.94605	2.29929	1.72077	1.62479	1.06156	2.48685	2.24236
6	2011	0.9	1.41249	0.90372	2.20767	1.52063	1.57237	1.02457	2.41307	2.07779
10	2011	1.0	1.35328	0.86360	2.12063	1.32437	1.52219	0.98919	2.34239	1.91679
14	2011	1.1	1.29706	0.82554	2.03790	1.13197	1.47413	0.95534	2.27462	1.75926
18	2011	1.2	1.24365	0.78942	1.95923	0.94337	1.42806	0.92294	2.20963	1.60514